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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 29591 and 29964.

29173 RADIOCHEMICAL MEANS OF INVESTIGATING DELAYED NEUTRON PRECURSORS. del Marmol, P. (CEN, Mol, Belg.). pp 75-83 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI/PUB-176; CONF-670424.

Fast radiochemical methods used now for the determination of delayed neutron precursors are classified and reviewed: precipitations, solvent extractions, range experiments, milking, gas sweeping, isotopic and ion exchange, hot-atom reactions, and diffusion loss. Advantages and limitations of irradiation systems with respect to fast separations are discussed: external beams which allow faster separations only have low neutron fluxes, internal beams which are mostly fit for gaseous reactions; and rabbits for solution irradiations. Future prospects of radiochemical procedures are presented; among these, studies should be mostly oriented towards gaseous reactions which offer possibilities of isolating very short-lived delayed neutron precursors. Chemical procedures for delayed neutron precursor detection were compared with mass spectrometric and isotope-separator techniques; it was concluded that the methods are complementary. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 29393, 29709, 29748, 30760, and 31052.

29174 (BNL-50229) DETERMINATION OF METALLIC AND NON-METALLIC TRACE IMPURITIES IN SODIUM METAL. Auerbach, Clemens (comp. and ed.) (Brookhaven National Lab., Upton, N. Y.). Jan 1970. 54p. Dep. CFSTI.

The methods used currently at Brookhaven National Laboratory for the determination of trace impurities in sodium metal are reported. Procedures are given for nonmetallic (oxygen, hydrogen, total carbon, carbonate carbon) and metallic (copper, chromium, manganese, cobalt, nickel, iron) impurities. In addition, methods are described for the following: (a) determination of trace nitrogen, carbon, and oxygen in vanadium-titanium-chromium alloys, which are being evaluated as container materials, and (b) determination of the composition of thoria-yttria ceramics, which are used as the solid electrolyte in oxygen meters. (auth)

29175 (CEA-R-3922) AUTOMATIC ELUTION APPARATUS: APPLICATION TO PLUTONIUM DETERMINATION. Kunzle-Lutz, Michele; Metivier, Henri (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Mar 1970. 24p. (In French). Dep. CFSTI (U. S. Sales Only).

An automatic elution apparatus for the separation of plutonium by anion exchange is described. The apparatus has ten free analytical ways controlled by the analysis operation itself. Several tests were performed for one year and the apparatus was found to be applicable commercially. (France)

29176 (CONF-700502-, pp 464-75) COMPARATIVE STUDIES ON LANTHANIDES AND ACTINIDES. Haire, R. G.; Lloyd, M. H.; Willmarth, T. E. (Oak Ridge National Lab., Tenn.); Milligan, W. O. (Baylor Univ., Waco, Tex.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Studies are reported, which have been made to characterize the hydroxide preparations of the actinide and lanthanide elements using electron microscopy, electron diffraction, and x-ray analysis. The hydroxide preparations were obtained by precipitating the metal ions from nitrate solutions with ammonium hydroxide. It was established that the initial hydroxide precipitates are amorphous-like in nature; however, upon sufficient aging in aqueous media, the material converts to a crystalline form. The investigation showed that the lanthanides can be divided into two groups, based on the crystallizing times and the microstructures obtained for the hydroxide preparations. For Am and Cm, the crystallization pattern is very similar to that of the lighter lanthanides but is complicated by radiolysis effects. Destruction of the crystalline forms by self-radiation was observed for these two elements. Actinides beyond Cm present special experimental problems due to their scarcity and their higher specific activities. Tetravalent Th, U, and Pu exhibit a different crystallization pattern than the above elements but are discussed for comparative purposes. (auth)

29177 (JUL-646-CA) ANALYSIS OF RADIOACTIVE URANIUM LEACH SOLUTIONS. II. Ge(Li) γ SPECTRA, URANIUM DETERMINATION. Petri, Hermann; Stoeppler, Markus (Kernforschungsanlage, Juelich (West Germany). Zentrallabor fuer Chemische Analyse). Feb 1970. 31p. (In German). Dep. CFSTI (U. S. Sales Only).

Results of γ-spectrometric measurements of uranium-leach solutions with a Ge(Li) detector and of fluorimetric uranium determinations are described and discussed. Finally a new uranium-leach apparatus for quantities up to 2 g of coated particles is proposed. (auth)

29178 (KFK-1133) DETERMINATION OF FREE ACID IN PLUTONIUM(IV) SOLUTIONS. Thiele, D.; Baehr, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Jan 1970. 12p. (In German). Dep. CFSTI (U. S. Sales Only).

The determination of free acid in nitric acid solutions of plutonium(IV) (up to 0.5 M) is described. Pu^{4+} is reduced to Pu^{3+} with mercury. Separation of reagents and reaction products is not needed before acidimetric titration. Uranium in a ratio of 10 to 1 plutonium does not interfere. Pu(VI) in larger amounts should not be present. The relative standard deviation is 0.4 to 1%. (auth)

29179 (NP-18228) DETERMINATION OF URANIUM IN MINERALS BY X-RAY FLUORESCENCE SPECTROSCOPY. Neuber, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Jan 1970. 41p. (In German). Dep. CFSTI (U. S. Sales Only).

The uranium content of minerals of various compositions and origins was determined by x-ray fluorescence spectroscopy. It is shown that for minerals that contain more than 3% uranium the determination can be carried out simply and exactly by dissolution of the minerals in aqueous solutions and use of plutonium as an internal standard. For minerals that contain between 3 and 0.05% uranium it was better to measure the samples in molten salt or completely undiluted. (M.C.G.)

29180 (ORNL-tr-2322) DETERMINATION OF HYDROGEN AND OXYGEN IN METALLIC URANIUM. Morimoto, Yoshio; Hirayama, Akil. Translated for Oak Ridge National Lab., Tenn., from Jap. Anal.; 11: 163-6(1962). 8p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 18: 1536.

29181 (PG-Report-928) ANALYTICAL METHOD FOR THE DIRECT DETERMINATION OF THE FLUORINE/URANIUM RATIO IN URANIUM DIOXIDE, URANOSO-URANIC OXIDE AND URANYL NITRATE LIQUOR, USING AN ION-SELECTIVE ELECTRODE. (United Kingdom Atomic Energy Authority, Springfields (England). Production Group). Apr 1970. 7p. Dep. CFSTI (U. S. Sales Only). UK 1s.

Uranium oxide samples are dissolved in nitric acid and the solution is then diluted. Uranyl nitrate liquors require only dilution. The resulting solutions contain uranium and nitric acid concentrations within specified limits. The fluorine/uranium ratio is measured directly using a fluoride ion-selective electrode and expanded-scale pH meter. The result obtained is independent of the amount of uranium in the sample aliquot within the specified limits of the method. (auth)

29182 MICRODROP SEMIQUANTITATIVE SPOT-COLORIMETRY. Rayner, L. W. W. (Post Office Research Dept., London). Microchim. Acta; No. 2, 193-9(1970).

A simple and inexpensive technique using microdrops for semiquantitative spot colorimetry gives useful results in the submicrogram range and may be used with any suitable spot-test reaction. Use of this method for determination of Ba and Sr is described. (auth)

29183 DEVELOPMENT OF AN X-RAY EMISSION SPECTROGRAPHY METHOD FOR THE DETERMINATION OF MOLYBDENUM IN OILS. Jovanovic, Dobrinka (Inst. for Tech. of Nuclear and Other Mineral Raw Materials, Belgrade). Anal. Chem.; 42: 775-6(Jun 1970).

The x-ray spectrograph was used in connection with two methods for the determination of Mo in oils. One method requires ashing of the oil sample, solution of the ash, and addition of an internal standard. An aliquot of the ash solution is analyzed with the x-ray spectrograph for Mo. The second method is faster than the first since Mo is determined directly in lubricating oil samples. The chief limitation is that a calibration curve must be prepared for each oil. Results from both methods compare favorably with those of spectrographic and spectrophotometric analyses. (J.G.B.)

29184 OXIDATION OF AROMATIC AMINES. Manolov, K. R.; Stamatova, V. T. (Institut fuer Lebensmittelindustrie, Plovdiv, Bulgaria). Microchim. Acta; No. 2, 222-8(1970). (In German).

The oxidation of aromatic amines with hydrogen peroxide in the presence of various metal ions leads to colored products and is suitable for the detection not only of these amines but also of the catalytically active metal ions. The limiting concentrations and the identification limits of several such reactions are given. (auth)

29185 SPECTROPHOSPHORIMETRIC MEASUREMENT OF NIOBIUM OXINATE AT LIQUID NITROGEN TEMPERATURE FOR DETERMINATION OF MICROGRAM AMOUNTS OF NIOBIUM. Kirkbright, G. F.; Thompson, J. V.; West, T. S. (Imperial Coll. of Science and Tech., London). Anal. Chem.; 42: 782-4(Jun 1970).

A method is reported for the determination of traces of niobium, based on the phosphorescence of its complex with 8-quinolinol in EPA (diethyl ether–isopentane–ethanol) at –196°C. Niobium oxinate is extracted into chloroform from aqueous citrate medium at pH 9.4; the chloroform solution is diluted with EPA. The phosphorescence intensity of the clear glass formed from this solution at –196°C is measured at 580 nm. The effects of 40 foreign ions on the determination was investigated. (J.G.B.)

29186 SIMPLE EQUIPMENT FOR TITRATION, MEASUREMENT, AND MIXING OF VERY SMALL VOLUMES OF SOLUTION. Knobloch, V.; Mudrova, B. (Nuclear Research Inst., Rez, Czech.). Microchim. Acta; No. 2, 235-9(1970).

A simple ultramicrotitration equipment is described, which permits measurement of from one to tens of μl of solutions, mixing of solutions, and certain titrations. The equipment can be used to prepare specimens for radiometric titrations, polarography, chromatography, and paper electrophoresis. (auth)

29187 EMISSION SPECTROGRAPHIC METHOD FOR DETERMINATION OF TRACE ELEMENTS IN FLUORSPAR. Huber-Schausberger, Ingeborg (Univ., Vienna). Microchim. Acta; No. 2, 240-53(1970). (In German).

A method was developed for the emission spectrographic analysis of trace elements in fluorspar. For the quantitative determination of the rare earths, the samples were mixed in the ratio of 4:1 with spectral carbon powder and photographed with a large lattice spectrograph at 16 amp/230 volts. Using scandium as reference element, the reproducibilities obtained lay between ±1.5 and ±4%. This method was supplemented by an accumulation procedure for removing the calcium by means of an ion exchanger. Consequently losses of from 10 to 15% may arise. Trials with 20-g portions of the starting material and an accumulation ratio from 1:100 to 1:200, enabled these workers to reach detection limits of 0.005 to 0.1 ppM. The quantitative determination of the other elements was accomplished with the aid of a prism spectrograph of medium dispersion. The samples were mixed with spectrum carbon powder in the ratio of 10:1 and photographed in the carbon arc (7 amp/230 volt). Indium and palladium were used as the reference elements. Detection limits in the case of individual elements as 0.03 ppM were attained. (auth)

29188 MASS SPECTROMETRIC DETERMINATION OF ZIRCONIUM, HAFNIUM, AND TITANIUM IN MIXTURES USING THE INTEGRATED ION CURRENT METHOD. Allcock, M. G.; Belcher, Ronald; Major, J. R.; Perry, Roger (Univ. of Birmingham, Eng.). Anal. Chem.; 42: 776-9(Jun 1970).

A procedure was developed for the rapid determination of hafnium in zirconium in the presence of other metals. The metal chlorides were converted to their diketonates in nonaqueous solutions. Zr, Hf, and Ti were determined by a mass spectrometric method using an integrated ion current technique. (J.G.B.)

29189 SPECTROFLUORIMETRIC DETERMINATION OF SUBMICROGRAM AMOUNTS OF ZIRCONIUM WITH CALCEIN BLUE. Hems, R. V.; Kirkbright, G. F.; West, T. S. (Imperial Coll. of Science and Tech., London). Anal. Chem.; 42: 784-7 (Jun 1970).

Submicrogram amounts of zirconium were determined by measurement of the fluorescence of the zirconium complex with Calcein Blue (3-aminomethyl-4-methylumbelliferone-N,N-diacetic acid). Effects of 30 cations and 10 anions on the determination were studied. (J.G.B.)

29190 PROBLEMS IN THE QUANTITATIVE SPECTRAL ANALYSIS OF THE RARE EARTHS. I. SPECTROGRAPHIC DETERMINATION OF SOME RARE EARTHS IN BAUXITES USING COPPER ELECTRODES. Zimmer, Karoly; Ikrenyi, Karoly. Magy. Fiz. Foly.; 76: 78-83(Feb 1970). (In Hungarian).

A spectrographic method was developed for determination of trace amounts of rare earths in bauxites without previous enrichment and without the use of a special apparatus and atmosphere. The use of a copper electrode and its performance are discussed. (tr-auth)

29191 FIELD METHOD FOR THE ESTIMATION OF URANIUM IN NATURAL WATERS. Heunisch, George W. (Continental Oil Co., Ponca City, Okla.). Microchim. Acta; No. 2, 258-61(1970).

A method, applicable in the field, for the quantitative determination of uranium at the 1-ppM level in natural water was developed. Equipment and reagents are listed. While 1-ppM solutions were analyzed lower concentrations can probably be evaluated in the same way. (auth)

29192 A NEW SPOT TEST FOR CERIUM(IV) USING TRIPHENYLMETHANE DYES. Rao, N. Venkateswara; Dutt, V. V. S. Eswara (Andhra Univ., Waltair, India). Microchim. Acta; No. 2, 292-6(1970).

A sensitive and selective spot test for cerium(IV) using the triphenylmethane dyes, Erioglaucine A, Eriogreen B, Xylenecyanol FF, Setoglaucine O, and Setocyanine Supra, respectively, is described. The method consists of adding one drop of the dye solution (0.1%) to a drop of cerium(IV) solution, and then treating the mixture with sufficient amount of sulfuric, perchloric, or phosphoric acid to maintain the acidity at 6 to 9 M. The colors produced with these dyes are: Erioglaucine A, orange; Eriogreen B, bright red; Xylenecyanol FF, orange yellow; Setoglaucine O, bright orange; and Setocyanine Supra, pink. The identification limit is 1 μg in 1.5 ml, and the dilution limit is $1:1.5 \times 10^6$ in all these cases. Many cations and anions do not interfere in the test, whereas reducing agents like Fe(II), Mo(V), U(IV), and hydroquinone, fluoride, and EDTA interfere. (auth)

29193 3-THIANAPHTHENOYLTRIFLUOROACETONE: A NEW REAGENT FOR THE SPECTROPHOTOMETRIC DETERMINATION OF CERIUM(IV). Holland, W. J.; Veel, A. E.; Gerrard, J. (Univ. of Windsor, Ont.). Microchim. Acta; No. 2, 297-300(1970).

A visible spectrophotometric method is described for the determination of cerium(IV) with 3-thianaphthenoyltrifluoroacetone. The effects due to pH, time, solvents, reagent concentration and diverse ions are reported. Beer's law is obeyed and the molar extinction coefficient is 5.51×10^3 at 424 nm. (auth)

29194 GEOKHIMIYA I ANALITICHESKAYA KHIMIYA REDKOZEMEL'NYKH ELEMENTOV. II. METODY ANALIZA RED-

KOZEMEL'NYKH ELEMENTOV ITTRIEVOI PODGRUPPY V PORODAKH I MINERALAKH UKRAINSKOGO SHCHITA. (Geochemistry and Analytical Chemistry of Rare Earth Elements. II. Methods for Determination of Rare Earth Elements in the Yttrium Subgroup in Rocks and Minerals in the Ukrainian Shield.) Kul'skaya, O. A.; Eliseeva, G. D.; Gornyi, G. Ya. Kiev, Izdatel'stvo Naukova Dumka (1969). 96p. (In Russian).

Spectrochemical, chromatographic, and chemical methods for the determination of individual rare earth elements in minerals and rocks are considered. Analytical data, obtained on large amounts of geological material, were used as a basis for studies of regularities in distribution of rare earth elements in the minerals of the decambrian granitoids in the Ukraine. New data are presented on methods for separation and quantitative determination of rare earth elements. (tr-auth)

29195 APPLICATION OF X-RAY FLUORESCENCE TO SILICATE ANALYSIS. Poole, A. B. (London Univ.). Proc. Brit. Ceramic Soc.; No. 16, 41-51(Apr 1970).

The scope, limitations, and possible future developments of the x-ray method in both routine analysis and the specialized techniques for handling unusual samples, or obtaining high analytical accuracy are reviewed. Routine procedures for elements above atomic number 10 involve the use of either powdered specimens prepared as tablets, or solid-solution beads made by fusing the sample material at about 1000°C with a flux such as lithium tetraborate. The advantages and disadvantages of these methods and the correction procedures sometimes used with them are discussed and illustrated with calibration curves prepared using chemically analyzed standard rock samples. The thin film method of examining very small amounts of sample spread over an adhesive film and the necessary calibration involving internal or external standardization is discussed. An outline of the "standard addition" procedure is given; this method allows precise analyses to be obtained when standard specimens are not available. Special modifications to standard equipment are described which allow quantitative analysis of unusual or small specimens down to 0.5 mm dia. (auth) (UK)

29196 SPECTROPHOTOGRAPHIC DETERMINATION OF METALLIC IMPURITIES IN ORGANIC COOLANTS FOR NUCLEAR REACTORS. Martin Munoz, M.; Alvarez Gonzalez, F. (Junta de Energia Nuclear, Madrid). An. Quim.; 64: 965-72(Nov 1968). (In Spanish).

A spectrochemical method for determining metallic impurities in organic coolants for nuclear reactors is given. The organic matter in solid samples is eliminated by controlled distillation and dry ashing in the presence of magnesium oxide as carrier. Liquid samples are vacuum distilled. The residue is analyzed by carrier distillation and by total burning techniques. The analytical results are discussed and compared with those obtained by a method in which the organic matter is destroyed without carrier and use of the copper spark technique. (auth)

29197 STUDY ON THE INFLUENCE OF CALCIUM, MAGNESIUM, AND SODIUM AND A METHOD FOR SPECTROGRAPHIC ANALYSIS OF NATURAL WATERS. Diaz-Guerra, J. P.; Capdevila, C. (Junta de Energia Nuclear, Madrid). An. Quim.; 64: 937-52(Nov 1968). (In Spanish).

The effects of 1000 μg/ml of calcium and sodium and 300 μg/ml of magnesium, on the spectrographic determination of Al, Ba, Cr, Fe, Li, Mn, Ni, Pb, Sr, and Ti, minor constituents in natural waters, were studied. In order to eliminate them, the elements Ba, In, La, Tl, and Zn, as well as a mixture containing 30% Tl–70% In, were tested as spectrochemical buffers. By means of the mixture mentioned and Ga, Tl, and Y as internal standards, the accuracy obtained for the quantitative determinations is better than 10%. On the other hand the semiquantitative determinations are improved through the use of Ga, In, or the Tl–In mixture. A further study indicated that it is possible to determine some of the elements up to a concentration of 4000 μg/ml of calcium, sodium, or both. The average standard deviation is about ±6%. (auth)

29198 DETERMINATION OF RARE AND TRACE ELEMENTS IN SEDIMENTARY AND IGNEOUS ROCKS. Cherevko, A. S. Tr. Sib. Nauch.-Issled. Inst. Geol., Geofiz. Miner. Syr'ya; No. 46, 207-11(1967). (In Russian).

Antimony, Pb, Ga, Cr, Bi, Ni, Be, Mo, Sn, V, Y, La, Yb, Zn, Sc, Zr, Mn, Tl, and Cd in rocks were determined simultaneously by emission spectrography. The 50- to 100-mg samples were mixed with a buffer mixture (C powder, 0.12% Ge, and 0.01% Pd). The spectrograph having a grating with 600 lines/mm was used. The spectrographic slit, 0.015 mm wide, was illuminated uniformly by a 3-lens system with intermediate image of electrodes on the screen of the second condensing lens. The height of the orifice of the intermediate diaphragm was 2 mm. The arc was fed by 10-amp ac at 220 V. Complete evaporation of the sample-buffer mixture occurred in 3 min from a channel of the C electrode with 0.3-mm wall thickness, 5-mm height, and 3.5-mm internal diameter. The following analytical lines for determining the elements and element of comparison (in A) and ranges of concentration (in %) were used: Sb 2598.1–Ge 2651.2 and 1 to 0.01; Pb 2833.1–Ge 2651.2 and 0.05 to 0.0005; Ga 2943.6–Ge 2651.2 and 0.01 to 0.0001; Cr 3021.6–Pd 3421.2 and 0.05 to 0.0001; Cr 3040.8–Pd 3421.2 and 0.5 to 0.005; Bi 3067.7–Ge 3039.1 and 0.01 to 0.003; Bi 2993.3–Ge 2709.6 and 0.5 to 0.005; Ni 3101.6–Pd 3421.2 and 0.03 to 0.0001; Ni 3031.9–Pd 3421.2 and 0.1 to 0.03; Be 3131.1–background and 0.005 to 0.001; Mo 3170.3–Pd 3421.2 and 0.1 to 0.0001; Sn 3175.0–Ge 3039.1 and 0.03 to 0.0001; Sn 2840.0–Ge 2651.2 and 0.1 to 0.003; V 3185.4–Pd 3421.2 and 0.01 to 0.001; V 3260.5–Pd 3421.2 and 0.1 to 0.001; Y 3216.7–Pd 3421.2 and 0.01 to 0.0001; Yb 3289.4–Pd 3421.2 and 0.01 to 0.0001; La 3337.5–Pd 3421.2 and 0.01 to 0.001; Se 3353.7–Pd 3432.2 and 0.01 to 0.0001; Sc 2974.0–Pd 3421.2 and 0.1 to 0.003; Co 3453.5–Pd 3421.2 and 0.01 to 0.0001; Co 3072.3–Pd 3421.2 and 0.1 to 0.003; Zr 3138.7–background and 0.5 to 0.003; Mn 3258.4–Pd 3421.2 and 0.3 to 0.001; Tl 3161.2–Pd 3421.2 and 0.5 to 0.001; Cd 3161.05–Ge 3039.11 and 0.1 to 0.001; and Zn 3282.3–Pd 3421.2 and 1.0 to 0.001. (Selenium–Tellurium Abstr.)

29199 COLORIMETRIC DETERMINATION OF IRON IN NIOBIUM COMPOUNDS. Klimczyk, H.; Kubas, Z.; Pytel, K.; Suski, L. Hutnik (Katowice); 35: 462-5(1968). (In Polish).

The sample is fused with $KHSO_4$ or KOH, and the Fe is extracted from the melt with 0.5N H_2SO_4, then determined as the complex with 1,10-phenanthroline. The error is ~±5% in the range 0.01 to 0.1% of Fe. (Anal. Abstr.)

29200 ABSORPTIOMETRIC DETERMINATION OF SCANDIUM IN AN YTTRIUM SALT WITH METHYLTHYMOL BLUE. Okun, A. E.; Fomenko, L. D. Uch. Zap. Kafedry Obshch. Khim. Kursk. Gos. Pedagog. Inst.; 35: 149-53(1967). (In Russian).

At an optimum pH of 3.1, Sc and Methylthymol Blue form a colored 1:2 complex (maximum absorption at 582 nm) suitable for the absorptiometric determination of Sc. Beer's law is obeyed with up to 1 μg of Sc/ml. The sensitivity of the reaction is 0.05 μg of Sc/ml. At pH 1.5 the sensitivity is less good, but the reaction is more selective; there is then no interference from the following elements—Y (330 μg/ml), Nd or Pd (80), In (145) and Zn (260). To determine small amounts of Sc in Y salts (containing traces of Nd, Pd, Zn, and In), to the test solution (<1 μg of Sc/ml) buffer solution of pH 1.5 and 1 ml of 0.7mM Methylthymol Blue are added; the solution is diluted to 25 ml with the buffer solution, and the extinction is measured against H_2O. (Referativnyi Zh.)

29201 QUANTITATIVE ANALYSIS OF RARE-EARTH METALS BY HIGH-VOLTAGE ELECTROPHORESIS. Virtanen, R.; Kivalo, P. (Technical Univ., Otaniemi, Finland). Acta Chem. Fenn.; 41: 184-7(1968).

The separation of La, Pr plus Nd, Sm, Eu, Gd, and Y was carried out by high-voltage electrophoresis (100 to 200 V per cm) of solution in $HClO_4$ on paper impregnated with 2-hydroxyisobutyric acid as complexing agent. After electrophoresis, the dried paper is sprayed with indicator solution (0.2mM Xylenol Orange in 2M ammonium carbonate), the colored zones are cut out, and the metals are isolated by ignition, or digestion with $HClO_4$–HNO_3, or extraction with dilute HCl then treatment with $HClO_4$–HNO_3. Each residue is dissolved in 0.1N HNO_3 and each metal is determined spectrophotometrically at 570 nm as its complex with 0.2mM Xylenol Orange, in a solution buffered to pH 6.1 with 0.2M hexamine and HNO_3. The samples examined contained 0.2 to 6 μmoles of each metal. It was necessary to remove Ce from the samples (by bromate oxidation) before electrophoresis to avoid overlapping of zones. (Anal. Abstr.)

29202 SEPARATION AND DETERMINATION OF URANIUM IN SEA WATER. Ogata, Noboru; Inoue, Nobuko (Odawara Salt Experiment Station, Kanagawa, Japan). Nippon Kaisui Gakkaishi; 23: 148-53(Feb 1970). (In Japanese).

A study was made to improve the separation method and fluorophotometric method for the determination of U in seawater without using the isotope dilution method. Uranium in the sample of seawater was adsorbed into titanic acid and extracted with mixture of sodium carbonate and sodium hydrogen carbonate at 100°C. The extracted solution was passed through in anion exchange resin of carbonate type, and the U adsorbed into the resin was eluted with HCl solution. The recovery of U by this method represented 90%, which was higher than the conventional methods but was still incomplete. Therefore, the condition of adsorption must be kept stable to obtain the recovery with small variation, and the determined value was corrected with the recovery. A given amount of this pretreated solution was pipetted into a Pt dish, dried, and melted at 665°C with carbonate–sodium fluoride

flux, and the fluorescence strength of the dish was measured. The error caused by the variation of melting condition could be decreased by using a furnace with a fan and correction by simultaneous operation with the U standard solution. The unevenness of the fluorescence strength in the dish could be decreased by using the temporary standard and rotating the fused dish during the measurement, and the measuring error was below 2%. Uranium content in seawater collected along the coast of Odawara showed 3.34 μg/l by this method. (auth) (NSA of Japan)

29203 CONTRIBUTIONS TO THE DETERMINATION OF TRACE ELEMENTS IN LIMITED AMOUNTS OF BIOLOGICAL MATERIAL. II. SEPARATION SCHEME AND DETERMINATION METHODS. Morsches, B.; Toelg, G. (Johannes Gutenberg-Univ., Mainz. Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Anal. Chem.; 250: 81-99(1970). (In German).

Nanogram amounts of As, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sn, Tl, V, and Zn can be determined in 100-mg samples of organic materials by micro-spectrophotometric, fluorimetric, and inverse voltammetric methods after decomposing the sample and separating the elements by liquid–liquid extraction methods. The separation scheme was tested by radiochemical and micro-spectrophotometric methods. The method was used to analyse for these elements in small amounts of human skin and fingernails. (auth)

29204 COLORIMETRIC DETERMINATION OF CERIUM. Suteu, A.; Hodisan, T. (Babes-Bolyai Univ., Cluj). Stud. Cercet. Chim.; 17: 973-84(Dec 1969). (In Rumanian).

The colorimetric methods for the determination of cerium, published up to 1968, are reviewed. They are classified as: methods based on the specific absorption of Ce(III) and Ce(IV) ions in the visible and the ultraviolet range; methods based on the reversible nature of the $Ce^{4+} + e^- \rightleftharpoons Ce^{3+}$ redox system, including the oxidation of various colorless organic compounds to colored ones by Ce(IV) and reduction of colored compounds to colorless ones by Ce(III); and methods based on the formation of colored complexes by a reaction between cerium and certain specific reagents. The survey revealed that most of the colorimetric methods are based on the determination of the Ce^{4+} ion. The oxidizing ability of this ion may be used to determine it in the presence of nonoxidizing rare earth elements. Most of the reactions involving complex formation of Ce(III) cannot be used in the presence of other rare earth elements which are also able to form such complexes; on the other hand, reactions involving Ce(IV) which yield colored complexes are more specific. (Review article, 87 references). (TTT)

29205 A DIRECT SPECTROPHOTOMETRIC DETERMINATION OF URANIUM IN ORGANIC SOLUTIONS OF TRI-n-BUTYL PHOSPHATE WITH ARSENAZO III. Emura, Satoru (Japan Atomic Energy Research Inst., Tokai). Jap. Anal.; 19: 637-42 (May 1970). (In Japanese).

For the direct spectrophotometric determination of uranium in organic solutions of tri-n-butyl phosphate (TBP) with Arsenazo III, an attempt was made to retain the uranyl Arsenazo III complex in a homogeneous mixture of 30% TBP/diluent–butyl cellosolve–water. The uranyl Arsenazo III complex in this medium has an absorption maximum at 653 nm and the absorbance showed a constant value at an acidity of nitric acid about 0.16M. Beer's law is obeyed up to 5.6 ppM of uranium(VI) and the apparent molar absorptivity at 653 nm is 3.58×10^4. The uranyl ion forms with Arsenazo III only the 1:1 chelate in 30% TBP/isododecane–butyl cellosolve–water medium. The mutual solubility between the organic solution and the aqueous solution of the reagent, the determinable region of uranium(VI), and the effects of diluents of TBP and diverse ions are also discussed. (auth)

29206 SPECTROPHOTOMETRIC AND FLUORIMETRIC DETERMINATION OF MICROAMOUNTS OF SULFATE USING THORIUM-FLAVONOL COMPLEX. Nasu, Toshiko; Kitagawa, Takahisa; Mori, Tagako (Hokkaido Univ., Sapporo). Jap. Anal.; 19: 673-80(May 1970). (In Japanese).

Thorium reacts with flavonol in a weakly acidic solution to form a stable complex having an absorption maximum at 390 mμ. The complex gives a blue fluorescence when its solution is irradiated with ultraviolet light. The color development of the thorium flavonal complex is suppressed by the presence of sulfate through the formation of sulfate complexes with thorium. The fluorescence of the complex is also quenched by sulfate through the same reaction. On the basis of these interactions, the methods of spectrophotometric and fluorometric determination of micro-amounts of sulfate have been established. The optimum pH of the solution was 2.4 to 2.7 for the spectrophotometry and, at this pH range, 300 μg of thorium and 400 μg of flavonol in 25 ml were satisfactory for the determination of 0.2 to 4.0 mg/l of sulfate, where the decrease of absorbance at 390 mμ (ΔA_{390}) was proportional to the amount of sulfate ion. For the fluorometry, the optimum pH range was 2.5 to 3.0, and 30 μg of thorium and 50 μg of flavonol in 25 ml were used for the determination of 0.02 to 0.8 mg/l of sulfate. The ratio of thorium to flavonol in the complex was 1:1. The concentration of ethanol affected the sensitivity of determination, and 30% ethanolic medium was employed in these procedures. The proposed methods were sensitive, manipulatively simple, and readily applicable to the determination of a large number of samples. Sulfate ion in natural waters was determined by this method with satisfactory results. (auth)

29207 ANALYTICAL APPLICATION OF X-RAY EXCITED OPTICAL FLUORESCENCE SPECTRA. 3. DETERMINATION OF RARE EARTH ELEMENTS IN HOLMIUM OXIDE AND ZIRCONIUM OXIDE. Kawaguchi, Hiroshi; Nakajima, Tokunosuke; Takashima, Kyoichiro; Ouchi, Yoshihiko (Japan Atomic Energy Research Inst., Tokai). Bunko Kenkyu; 18: 299-305(Dec 1969). (In Japanese).

Holmium was analyzed indirectly by diluting it with yttrium oxide. After the solutions of the holmium sample and high purity yttrium were mixed (Ho:Y = 1:100, by weight), oxalic acid solution was added to the mixture to precipitate the oxalate. The precipitate was filtered, dried, and fired at 1000°C for 1.5 hours. The oxide powder thus prepared was irradiated by x rays, and emission lines of Dy (572 mμ), Gd (315 mμ) and Eu (611 mμ) were measured. The detection limits of these elements in holmium were 5, 50 and 30 ppM, respectively. The intensities of x-ray-excited optical fluorescence of rare earth elements in zirconium oxide were found to be strongly enhanced by addition of several per cent of thorium oxide to it. Zirconium and thorium were coprecipitated from the solution using ammonium hydroxide (Zr:Th = 10:1, by weight). The precipitate was filtered, dried, and fired at 1000°C for 1.5 hours. Fluorescences of Pr, Eu, Er, Ho, and Sm were all detectable in a mixed matrix, while only Dy, Gd, and Tb showed positive responses in pure zirconium oxide. Detection limits of these elements and quenching effects due to residual impurities were also investigated. (auth)

29208 ESTABLISHMENT OF EXPERIMENTAL VARIABLES FOR THE DETERMINATION OF RARE EARTHS BY X-RAY FLUORESCENCE SPECTROMETRY. APPLICATION TO CONCENTRATIONS OF OXALATES AND SULFATES. Bayon Fuentes, A.; Bermudez Polonio, J. (Junta de Energia Nuclear, Madrid). An. Quim.; 64: 825-32(Sep-Oct 1968). (In Spanish).

A theoretical and experimental study was carried out in order to analyze the rare earth elements by x-ray fluorescence spectrometry. All possible spectral interferences are considered. The working conditions for each element were selected, taking into account the peal–background ratio values for the following parameters: tungsten, molybdenum, and chromium targets, current and voltage, analyzing crystals, and scintillation and flow proportional counters. Calibration curves were plotted showing the concentration of rare earth elements in oxalates and potassium sulfate matrices. The theoretical detection limits for each element were calculated. (auth)

Isotopic Procedures

29209 A CONVENIENT ISOTOPIC DILUTION METHOD FOR THE DIRECT DETERMINATION OF OXYGEN IN FLUORINATED ORGANIC MATERIALS. Olson, Paul B.; Kulver, Sven (Minnesota Mining and Mfg. Co., St. Paul). Microchim. Acta; No. 2, 403-12(1970).

A method is described for the microdetermination of oxygen in fluorinated organic compounds. The unknown material is pyrolyzed together with ^{16}O-containing succinic acid, in a sealed, evacuated, specially-purified copper tube. After equilibration at 850°C, the tube is punctured and the pyrolysis gases are admitted to a mass spectrometer. Comparison of the m/e-46/44 ratio ($C^{16}O^{18}O/C^{16}O^{16}O$) to the ratio obtained from similar pyrolysis of the oxygen-18 compound only, provides a means of calculating the oxygen content of the unknown. The procedure was used successfully for a variety of fluorinated compounds including several metal salts of fluorinated acids. (auth)

Radiometric Procedures

Refer also to abstracts 29516, 29550, 29562, and 30685.

29210 (CEA-CONF-1535) PLUTONIUM ISOTOPES DETERMINATION. Acena, M.; Pottier, R.; Koehly, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1969. 42p. (In French). (CONF-691122-1). Dep. CFSTI (U. S. Sales Only).

From 2nd Spanish-French Symposium on Fuel Reprocessing and Plutonium Chemistry, Madrid, Spain.

Two radiometric procedures were developed for determination of ^{236}Pu in ^{238}Pu and ^{241}Pu in ^{242}Pu. The separation of uranium from plutonium and of americium from plutonium is described. The preparation of the uranium, plutonium, or americium sources by electrodeposition is given. The device comprises an α detector and γ detector oppositely connected. The α spectra of U, Pu, and Am sources and those of Pu and Am sources in α-γ coincidence are given. A correction made on the residual nuclides and the aging time necessary between ^{238}Pu purification and its analysis have to be taken into account for the error calculation made for ^{236}Pu. Errors are also estimated for ^{241}Pu. The results thus obtained are found to be in agreement with those found by α spectrometry for ^{236}Pu and by mass spectrometry for ^{241}Pu. (France)

29211 (LIB/Trans-280) CHEMICAL ANALYSIS BY METHOD OF LARGE ANGLE SCATTERING OF HEAVY IONS. Karamyan, S. A.; Shukurov, Ya. Translated by K. Cecers (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from At. Energ. (USSR), 20: 56-7(Jan 1966). 5p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 20: 29090 (1966).

29212 (SZS-1/70, pp 1-7) RAPID RADIOCHEMICAL DETERMINATION OF ^{137}Cs IN WATER. Rehak, W.; Ubl, G. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German).

The radiochemical determination of ^{137}Cs in water samples free of suspended matter is performed by an ion exchange procedure with ammonium molybdophosphate (AMP) and measuring the beta activity of the ion exchanger. A simple procedure for the preparation of AMP with good exchanging properties is described. (auth)

29213 (SZS-1/70, pp 8-18) RADIOCHEMICAL DETERMINATION OF ^{137}Cs IN SOIL. Rehak, W.; Feddersen, B. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German).

A radiochemical method for the determination of ^{137}Cs in soils is described. The method is characterized by the decomposition of the soil by NaOH, the separation of ^{137}Cs and carrier cesium by a batch extraction with ammonium molybdophosphate, and measurement of the beta activity of the Cs_2PtCl_6 precipitation. The efficiency of various methods of decomposition of the soil is compared. (auth)

29214 (SZS-1/70, pp 19-30) RADIOCHEMICAL DETERMINATION OF ^{144}Ce AND ^{141}Ce IN ENVIRONMENTAL SAMPLES. Rehak, W.; Ubl, G. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German).

An analytical method is described for determination of ^{144}Ce and ^{141}Ce in environmental samples. The method is based on the extraction by bis(2-ethylhexyl) phosphate. (auth)

29215 ERROR ANALYSIS AND SYNTHESIS IN THE GAMMA SCANNING OF TEST REACTOR ELEMENTS. Spraktes, Floyd, W. (Idaho Nuclear Corp., Idaho Falls). Int. J. Nondestruct. Test.; 1: 285-93(Feb 1970).

The ^{235}U content in ETR fuel elements was determined by gamma scanning. Factors that could introduce significant errors into the estimation were considered. Uncertainty in the estimated ^{235}U content of standards, reproducibility, length of the cores, width of the cores, variations in ^{235}U content of the plates, side plate thickness, and fuel plate thickness are discussed. (M.C.G.)

29216 NEUTRON INTERROGATION TECHNIQUES IN FISSIONABLE MATERIAL ASSAY. Keepin, G. Robert (Los Alamos Scientific Lab., N. Mex.). Int. J. Nondestruct. Test.; 1: 401-28 (Feb 1970).

The method of neutron interrogation is described and its advantages over passive methods of analysis are considered. Results of absolute delayed-neutron yield measurements are presented. The correlation between delayed-neutron and γ yields for different fission isotopes is illustrated. A program for fissionable scrap assay is described. (M.C.G.)

29217 RADIOCHEMICAL METHOD FOR THE DETERMINATION OF SULFUR IN METALS. Oudar, Jacques; Barbouth, Nisso (Univ., Paris). Bull. Soc. Chim. Fr.; No. 3, 834-6(Mar 1970). (In French).

A new, nondestructive, radiochemical method is described. It is necessary to use a standard solution of ^{35}S and to measure the absorption coefficient of the ^{35}S beta radiation in the metal studied. Accurate fractions of 1 ppM of dissolved sulfur can be determined. (France)

29218 BODY POTASSIUM MEASUREMENTS WITH A TOTAL-BODY COUNTER. Tyson, Ian; Genna, Sebastian; Jones, Robert L.; Bikerman, Valentine; Burrows, Belton A. (Boston Veterans Administration Hospital, Boston Univ.). Contract AT(30-1)-3099. J. Nucl. Med.; 11: 255-9(Jun 1970).

Body potassium was determined by measurements of naturally occurring radiopotassium in normal human subjects using a total-body counter. Phantom studies were carried out to demonstrate the effects of variations in body build on ^{40}K measurements using a "scanning" geometry. Use of an index based on body build permits body potassium to be calculated from the ^{40}K counting rate with an error of ±5%. More accurate information can be obtained by ^{42}K calibration to correct for effects of body build and potassium distribution on the ^{40}K counting rate. (auth)

29219 ABSOLUTE MEASUREMENT OF WHOLE-BODY POTASSIUM BY GAMMA-RAY SPECTROMETRY. Cohn, S. H.; Dombrowski, C. S. (Brookhaven National Lab., Upton, N. Y.). J. Nucl. Med.; 11: 239-46(Jun 1970).

The development of a 54-detector whole-body counter makes possible the absolute measurement of whole-body potassium, irrespective of the size and habitus of the subject. With this counter it is also possible to delineate the spatial distribution of potassium in the body after correction for absorption and geometry. The counter is relatively invariant in response to the spatial distribution of the deposited radionuclide and to the mass absorption effects of the human body. The level of potassium was measured in 425 normal subjects and expressed in terms of age, body weight, and other parameters. (M.C.G.)

29220 EFFECT OF ACID LEACHING ON ALPHA-INDEX OF SIZE FRACTIONS OF MONAZITE AND ZIRCON SANDS. Sastri, C. S.; Sivaramakrishnan, V. (Indian Inst. of Tech., Madras). Curr. Sci. (India); 39: 229-30(20 May 1970).

The effects of acid leaching on the alpha-index of the naturally occurring fraction of beach placers of monazite and zircon, collected from the Manavalakurichi area in Tamil Nadu (Madras State), India was studied. A scintillation counter was used to determine ages by the lead-alpha method. Acid leaching was found to cause appreciable change in alpha activity in certain size fractions of both monazite and zircon. (J.G.B.)

29221 FUNDAMENTAL FISSION SIGNATURES AND THEIR APPLICATIONS TO NUCLEAR SAFEGUARDS. East, L. V.; Keepin, G. R. (Los Alamos Scientific Lab., N. Mex.). pp 647-66 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Practical active interrogation methods are being developed using sources of neutrons to induce fissions in the material under investigation. In these methods, quantitative assay is based on detailed observations of the delayed and prompt neutrons and gamma rays from fission. The characteristic differences in the yields and kinetics of delayed neutrons from the various fission species provide a unique method for analysis of individual fissionable isotopes in unknown mixtures; assay methods using these signatures are described. To investigate fully all possible signatures of individual fissionable isotopes, one must have detailed knowledge of the various emissions associated with the fission process. For this reason, a number of fundamental measurements of these emissions are being performed at Los Alamos. A review of the delayed-neutron and gamma work is presented. (auth)

29222 NEW METHOD FOR THE DETERMINATION OF ^{90}Sr IN URINE. Testa, C.; Santori, G. (CNEN, Rome). Energ. Nucl. (Milan); 17: 320-4(May 1970).

This method is based on the application of a batchwise separation process of yttrium-90 with Microthene-710 (microporous polyethylene) supporting the liquid cation exchanger di(2-ethylhexyl) orthophosphoric acid (HDEHP). Urine samples (500 ml) are added to 5 mg of stable strontium and yttrium, 25 ml conc. HNO_3, and 5 ml H_2O_2. The pH is brought to 0.5 and the samples are stirred for 20 minutes with a slurry consisting of 5 g Microthene (50 to 100 mesh) supporting 5 ml HDEHP 50% in toluene. The slurry is transferred to a 25 mm chromatographic column and washed quickly with 0.3M HNO_3; yttrium-90 is then eluted with 100 ml 6M HNO_3 and the solution concentrated up to 10 ml. After addition of ammonium oxalate, yttrium oxalate is precipitated and counted in a low background beta detector. From yttrium-90 decay the original strontium-90 activity can be obtained. The yield was 92 ± 8% with a sensitivity limit of 5 pCi/liter. (auth)

29223 THE BETTER SCREWDRIVER: A NEW, NONDESTRUCTIVE NUCLEAR FUEL ASSAY MACHINE. Untermyer II,

Samuel (National Nuclear Corp., Palo Alto, Calif.). Int. J. Nondestruct. Test.; 1: 223-35(Oct 1969).

A method for nondestructive fuel assay based on 60 to 1000 keV neutron interrogation is described and compared with other methods. A schematic drawing of the apparatus is given. Data on results are presented in graphs. (M.C.G.)

29224 METHOD OF DETERMINING ^{210}Pb. Lisachenko, E. P. Gig. Sanit.; No. 12, 59-61(Dec 1969). (In Russian).

A new γ spectrometric method was developed to determine ^{210}Pb on the basis of the soft γ radiation of the naturally occurring material. Decay of ^{210}Pb yields ^{210}Bi in its excited state, passing into the ground state under emission of a 46-keV γ quantum. This radiation was determined by means of a low-background γ spectrometer, calibrated in the soft radiation range with an equilibrium lead–polonium solution. In order to test the instrument, the ^{210}Pb concentration of the samples was determined in the presence of ^{137}Cs, taking into account that ^{90}Sr and ^{90}Y may also be present. In order to be able to determine ^{210}Pb in natural samples after only a simple concentration step, work has started on increasing the sensitivity of the instrument. In view of the very low energy levels involved, if the volume of the sample is increased, the effect of density and experimental geometry on the absorption must also be carefully evaluated. (TTT)

Activation Procedures

Refer also to abstract 29308.

29225 (LYCEN-7016) OXYGEN DETERMINATION IN SILICON BY ACTIVATION BY α PARTICLES. Thomas, Jean-Paul (Lyon Univ. (France). Institut de Physique Nucleaire). Mar 1970. 75p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

The validity and limits of the empirical laws on stopping powers and charged particles range in complex chemical materials are examined. The energy dispersion of the incident particles, enhanced by straggling in thick samples, introduces a distortion in the activation curves that may be calculated in simple cases. Correction factors may be introduced. Analysis is not made impossible by this dispersion, but requires the determination of the mean cross sections. In the particular case of oxygen determination in silicon, interference reactions giving rise to ^{18}F, ^{24}Na, and ^{29}Al, appear at energies higher than 40 MeV and make any determination of oxygen impossible by α particles with an energy >40 MeV. The surface state of the analyzed samples and the thickness of the superficial oxidized layer are examined. Those reactions could not result from diffusion processes developed on the surface. The influence of the purity of the incident particle beam is preponderant: a deuton contamination of the α beam introduces a notable error in apparent oxygen concentration. By a decrease both in the maximum energy of the α particles and in their energy dispersion and by using a pure beam, oxygen determination in silicon is made possible for very low concentrations (0.1 ppM). (France)

29226 (NP-18222) ACTIVATION ANALYSIS: A BIBLIOGRAPHY. Part 1, Addendum 1; Part 2, Revision 1. Lutz, G. J.; Boreni, R. J.; Maddock, R. S.; Meinke, W. W. (eds.) (National Bureau of Standards, Washington, D. C.). Dec 1969. 420p. (NBS-TN-467(Pt.1)(Add.1); NBS-TN-467(Pt.2)(App.)(Rev.1)). GPO $8.50 per set of 2 volumes.

References to activation analysis in the open literature are published from a computer readout. With this addendum, the first part of the two-part series contains more than 6,000 references numbered according to their accession to the system. The second part contains an author index and three additional indexes for Element Determined, Matrix Analyzed, and Technique Used. Part 1 is updated by this addendum to include new references. Part 2 is superseded by revision 1 to include cross references to the new accessions listed in part 1. (auth)

29227 SEMIQUANTITATIVE ANALYSIS OF MIXED GAMMA-RAY SPECTRA BY COMPUTERIZED LEARNING MACHINES. Wangen, L. E.; Isenhour, T. L. (Univ. of Washington, Seattle). Anal. Chem.; 42: 737-43(Jun 1970).

Learning machine methods were applied to the semiquantitative determination of seventeen light elements by resolution of 14 MeV neutron-induced gamma spectra. Individual spectra are combined to produce complex patterns with which weight vectors are trained by an error forcing iterative process designed to minimize computational time. Weight vectors are trained at order of magnitude intervals for each of the 17 elements and each is tested on 1000 randomly generated mixture spectra which include radioactive counting statistical variations. (auth)

29228 DETECTION LIMITS FOR GAMMA-RAY SPECTRAL ANALYSIS. Rogers, V. C. (Brigham Young Univ., Provo, Utah). Anal. Chem.; 42: 807-8(Jun 1970).

Previously reported general expressions for the limits of detection and quantitative determination were expanded upon to include various numbers and combinations of channels. The dependence of the detection limits upon the number of channels in the peak was observed. It is noted that statistical uncertainties associated with gamma spectra are usually reduced with the use of spectrum-smoothing techniques. (J.G.B.)

29229 USE OF GERMANIUM DETECTOR FOR NEUTRON-RADIATION ANALYSIS OF ELEMENTS AND ISOTOPES CONTENT. Demidov, A. M.; Govor, L. I.; Ivanov, V. A. At. Energ. (USSR); 28: 115-20(Feb 1970). (In Russian).

Possibilities of the neutron activation analysis of elements,and isotopes by use of a germanium detector are discussed. Analysis with the use of neutron capture gamma spectra is discussed. A classification of elements in accordance with a magnitude of their detection sensitivity is presented. Also presented are results of analyses of some geological samples and materials (dural, Cu–Ni alloy, clay with sand, calcite zircon, apatite, monazite, scheelite, gypsum) as well as of neodymium and barium isotopes performed using a thermal neutron beam from the IRT-M reactor. (auth)

29230 METHOD OF ANALYZING FISSIONABLE MATERIALS IN SOLUTIONS BY BRIEF NEUTRON IRRADIATION. Bogatyrev, V. K.; Dubovskii, B. G.; Frolov, V. V. At. Energ. (USSR); 28: 111-15(Feb 1970). (In Russian).

Data on a quantitative determination of the content of fissionable materials in solutions by use of the method of brief neutron irradiation from a Sb–Be source are presented. The irradiation is followed by subsequent registration of fast fission neutrons, the intensity of which is proportional to the concentration of fissionable nuclei. Fast fission neutrons can be registered with a fast neutron threshold detector as well as with a thermal neutron detector. In the latter case a detector (for example, a counter with ^{3}He) must be surrounded with a moderator layer and with a sheet of cadmium, and removed from beryllium for as far as about 15 cm. This distance corresponds to three relaxation lengths for neutron fission spectrum and to ten relaxation lengths for 24-keV neutrons. By use of a ^{124}Sb source with activity of about 100 μ curie a sensitivity of about 1 mg/l for ^{235}U was achieved. (auth)

29231 PARTITION OF TRACE ELEMENTS BETWEEN ROCK-FORMING MINERALS AND THE HOST VOLCANIC ROCKS. Higuchi, Hideo (Rikkyo Univ., Yokosuka, Japan); Nagasawa, Hiroshi. Earth Planet. Sci. Lett.; 7: 281-7(Dec 1969).

Partition coefficients for 1+ to 4+ valence trace ions between ground mass of volcanic rocks and the coexisting phenocrysts of plagioclase, biotite, hornblende, and olivine were determined by neutron activation analysis. The result supports the mechanism proposed by Onuma et al. that the trace element partition between phenocryst and ground mass is determined by crystal structure of the phenocryst. (auth)

29232 DETERMINATION OF MANGANESE, COPPER, NICKEL, TUNGSTEN, AND SODIUM IN MOLYBDENUM WITH A SINGLE NEUTRON IRRADIATION. Fedoroff, M. (Centre National de la Recherche Scientifique, Vitry-sur-Seine, France). Bull. Soc. Chim. Fr.; No. 3, 1233-6(Mar 1970). (In French).

Manganese, copper, nickel, tungsten, and sodium determinations in molybdenum are made after irradiations (20 minutes to 48 hours) in the EL3 reactor. This analysis estimates the sample purity very quickly. A systematic analysis takes longer. Three ion-exchange columns eliminate molybdenum and technetium after irradiation and dissolution of the metal. The titration results give a control of the purification of molybdenum. (France)

29233 STUDY OF SOME SELECTED TRACE ELEMENTS IN NORMAL AND CANCEROUS TISSUE BY NEUTRON ACTIVATION ANALYSIS. Danielsen, A.; Steinnes, E. (Rikshopitalet, Oslo. Institutt for Atomenergi, Kjeller, Norway). J. Nucl. Med.; 11: 260-4(Jun 1970).

Small biopsies were removed by surgical operation for the analyses. If possible, neoplastic tissue as well as normal tissue from the same organ was taken. The tissues were analyzed for Cu, Zn, K, and Rb. Samples of 3 to 35 mg, dry weight, were irradiated for 5 days at a neutron flux of about 1.5×10^{13} n/cm^2/sec in the JEEP II reactor. Separations were carried out and activity measurements made. It appeared that the concentration of Zn was generally lower in neoplastic tissue than in corresponding normal tissue. No significant differences were observed for Cu. The K content was significantly different in neoplastic and normal tissue. (M.C.G.)

29234 ACTIVATION ANALYSIS. Rakovic, Miloslav. Prague; Academia (1970). 339p.

Translated by Neklan Mastalir.

Principles and significance of neutron, charged particle, or γ activation analysis are discussed. The analysis of metals and alloys, nonmetallic elements, inorganic compounds, organic materials, reactor materials, meteorites, geological samples, water, biological materials, and miscellaneous materials for forensic science and archaeology are considered. (M.C.G.)

29235 RAPID INDUSTRIAL DETERMINATION OF OXYGEN IN STEELS BY NEUTRON ACTIVATION. Kalmar, Elemer; Raboczki, Janos; Tar, Jozsef; Varga, Lajos. Banyasz. Kohasz. Lapok, Kohasz.; 102: 247-53(Jun 1969). (In Hungarian).

The method, equipment, reproducibility, and accuracy are discussed; the results were compared with those obtained by vacuum extraction. The problems of sample taking and preparation, the distribution of O in the liquid open hearth steel, and the distribution of O in the billets and in the final sheet are discussed. (Metals Abstr.)

29236 PRELIMINARY RESULTS ON CHEMICAL SEPARATION OF RUTHENIUM FROM MOLYBDENUM MINERAL BY DISTILLATION AND ISOTOPE ANALYSIS OF RUTHENIUM BY SURFACE IONIZATION. Takaoka, Nobuo (Osaka Univ., Toyonaka, Japan). Shitsuryo Bunseki; 18: 888-93(Mar 1970). (In Japanese).

Preliminary results are reported on the separation of small amounts of Ru from large amounts of molybdenum sulfide and on the neutron activation analysis of Ru in a molybdenite. The chemical yield for Ru in the distillation was checked by using a radioactive tracer ^{106}Ru ($T_{½}$ = 1 yr) and by counting 512 and 622 keV γ rays from ^{106}Rh ($T_{½}$ = 30 sec) which is in radiation equilibrium with ^{106}Ru. Molybdenum sulfide was fused with sodium peroxide flux, and then the black slurry extracted by water was dissolved by sulfuric acid (1:2) in a distillation flask. A known amount of tracer ^{106}Ru was added to the solution. Osmium was removed by the distillation with 30% H_2O_2. The ruthenium was distilled using sodium bromate (20%) and concentrated sulfuric acid added in the flask and with the air current through the distillation apparatus. The distillate was absorbed in two receivers, each containing 5 ml of 9N sodium hydroxide or 10 ml of 5% ethanol-0.2 N hydrochloric acid mixture. The counts of recovered ^{106}Ru were compared with the counts of the added one, the distillation yield of 96.5% Ru was obtained in a single distillation, and in the doubly repeated 99.5%. In order to determine an amount of Ru in the molybdenite quantitatively, 85 mg of the molybdenite was bombarded by pile neutrons, together with a standard sample including 7.9 μg of Ru. The Ru was separated from each neutron-irradiated sample by the distillation procedure. As a carrier, 216 μg of Ru was added at the stage of fusion of the neutron-irradiated molybdenite. The distillate for the molybdenite was compared with the one for the standard sample by counting 498-keV γ rays from radioactive ^{103}Ru($T_{½}$ = 40 d) resulted from the neutron capture on ^{102}Ru. The countings were undertaken using a NaI(Tl) scintillation counter with an anticoincidence guard, along with a 512-channel pulse-height analyzer. The concentration of Ru in the molybdenite was estimated to be 37×10^{-9} g/g. An isotopic abundance of reagent Ru was tentatively measured by a single focusing mass spectrometer with a surface ionization source of a tungsten single filament. About 5 μg of Ru as chloride was heated to dryness on a tungsten filament in air, and then was preheated to dull red in a vacuum for two days. The isotopic abundance obtained is reported. (auth) (NSA of Japan)

29237 APPLICATION OF γ-ACTIVATION METHOD FOR QUANTITATIVE DETERMINATION OF NITROGEN AND PHOSPHORUS IN THE MODIFIED CELLULOSE. Miller, R. A.; Khakimov, M.; Yuldashev, A. Yu.; Muratova, U. M.; Sadykov, M. M.; Usamanov, Kh. U. (Tashkent State Univ., Research Inst. of Chemistry and Tech. of Cotton Cellulose, Tashkent). Vysokomol. Soedin., Ser. A; 12: 957-9(Apr 1970). (In Russian).

A γ-activation technique was developed for determination of phosphorus and nitrogen in modified cellulose samples. The sample is irradiated in a betatron for 5 min at maximum energy of the slowed 15 MeV γ-beam and 6000 R/sec. Measurement of induced activity is carried out with a coincidence spectrometer for recording the positron annihilation. The components are separated by means of their half-life periods using the least squares method or nomograms. The sensitivity of the technique is 0.5%, maximum error is 5%, and time of analysis is not more than 30 min for the sample. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 29176, 29324, 29339, 29353, 29963, 29964, 30013, 30027, 30028, 30043, and 31039.

29238 (CONF-700502-, pp 113-22) PROCESS CONTROL IN URANIA PREPARATION BY THE SOL-GEL PROCESS. McBride, J. P.; Pattison, W. L.; Finney, B. C.; McCorkle, K. H. (Oak Ridge National Lab., Tenn.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

A new process for preparing concentrated, crystalline urania sols by solvent extraction was developed. This process depends upon a controlled extraction of nitrate from a U(IV) nitrate-formate solution, using a long-chain amine in a hydrocarbon diluent, and permits a measure of process control and of reproducibility of product properties hitherto unattainable. It is in routine use in engineering-scale equipment and consistently produces 1 M sols that remain fluid for 3 mo or longer. (auth)

29239 (CONF-700502-, pp 448-63) APPLICATION OF MASS TRANSFER THEORY TO DESIGN OF GELATION COLUMNS. Wace, P. F.; Simpson, M. P. (Atomic Energy Research Establishment, Harwell (England)).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Mass transfer theory is applied to the rate of extraction of water from sol droplets falling through an immiscible drying medium. An expression is derived for the height of a gelation column, and the method of its solution described. Agreement between theory and experiment is noted. Selection of the column diameter is made by calculating limiting hold-ups of the dispersed phase, and the rate of collision of gelling droplets. An example design for the production of 10 kg/day of half-millimetre thoria spheres is used to illustrate the methods. (auth)

29240 (CONF-700502-, pp 476-509 MODEL FOR SHRINKAGE OF THORIA GEL BASED ON KINETICS AND SURFACE CHARACTERIZATION USING INFRARED SPECTROSCOPY. Olson, F. A.; Olsen, C. S.; Chang, R. K.; Wadsworth, M. E. (Utah Univ., Salt Lake City).

From Symposium on Sol-Gel Processes and Fuel Cycles.

A model for irreversible shrinkage of thoria gel with outgassing in the range 200 to 500°C is presented on the basis of 1) desorbed species, 2) adsorbed states, 3) a weight loss shrinkage relationship, and 4) shrinkage kinetics. Desorbed species were H_2O, NO_2, and CO_2 and on the basis of in situ infrared spectroscopic measurements the chemisorbed states involved hydroxyl (OH), nitrato (ONO_2) and with some conjecture carbonate and bicarbonate groups. Shrinkage due to loss of chemisorbed species was linearly related to weight loss and the rate was inversely and exponentially dependent on the amount of species chemisorbed. The model illustrates a change from Van der Waals to covalent (partially ionic) bonding of the 70 Å radius gel polyhedra with removal of chemisorbed species and subsequent shrinkage. (auth)

29241 (JINR-P12-5120) EXPERIMENTS ON CHEMICAL IDENTIFICATION OF SPONTANEOUSLY FISSIONABLE ISOTOPE OF ELEMENT 105. Zvara, I.; Belov, V. Z.; Korotkin, Yu. S.; Shalaevskii, M. R.; Shchegolev, V. A.; Hussonnois, M.; Zager, B. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1970. 13p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Experiments were performed on the chemical separation of radioactive products obtained in the bombardment of ^{243}Am with accelerated ^{22}Ne ions (compound nucleus-element 105) by adsorption of gaseous chlorides from flowing carrier gas on the surface of a glass tube, over which a temperature gradient was established. It was found, that the chloride of the spontaneous fission activity present is less volatile than niobium chloride but not less volatile than hafnium chloride. Such volatility properties are predicted for element 105, ekatantalum. Eighteen decay events were detected. (auth)

29242 DICHLORODIHYDROXYURANIUM(IV) AND BIS(TRIPHENYLPHOSPHONIUM) TETRACHLORODIHYDROXYURANATE(IV). Hayton, B.; Smith, B. C. (Birkbeck Coll., London). J. Inorg. Nucl. Chem.; 32: 1219-21(Apr 1970).

The partial hydrolysis of uranium tetrachloride gives dichlorodihydroxyuranium(IV), which reacts with triphenylphosphine and hydrogen chloride to give bis(triphenylphosphonium) tetrachlorodihydroxyuranate(IV). Clathrates of apparent composition $(Ph_3PH)_2UCl_6 \cdot C_6H_{11}OH$ and $(Ph_3PH)_2UCl_4(OH)_2 \cdot A$ are formed with some alicyclic compounds (A = C_6H_{12}, $C_6H_{11}OH$, 1-Me$C_6H_{10}OH$, and $C_6H_{10}O$). (auth) (UK)

29243 ACTIVATION OF MOLECULAR HYDROGEN OVER SOME HIGHER NEGATIVE IONS OF METAL-TETRAPHENYLPORPHIN FILMS. Ichikawa, Masaru; Soma, Mitsuyuki; Onishi, Takaharu; Tamaru, Kenzi (Tokyo Univ.). Z. Phys. Chem. (Frankfurt); 68: 309-11(Dec 1969).

Complex films were deposited over a silica wool from solutions of each of the metal-tetraphenylporphines (M-TPP, M = Zn(II), Cu(II), and Ni(II)). When each of the stoichiometric complex films

(1:1 and 1:2) of Zn–, Ni–, and Cu–TPP was exposed to hydrogen at 20 to 90°C, hydrogen was sorbed slowly and the H_2-D_2 reaction took place. It is noted that the more negative ions (–3 and –4) of the metal porphins showed marked catalytic activities for the hydrogen chemisorption and hydrogen exchange reactions. Hydrogen activation increased with decreasing reduction potential. Hydrogenation of olefins such as ethylene, propylene, and butenes took place readily over the complex films. (J.G.B.)

29244 MEDIUM EFFECTS ON THE EXCHANGE OF CHLOROCHROMIUM(III) ION AND CHROMIUM(II) ION. James, Ronald V.; King, Edward L. (Univ. of Colorado, Boulder). Inorg. Chem.; 9: 1301–4(Jun 1970).

The exchange of chromium-51 between chromium(II) ion and chlorochromium(III) ion was studied as a function of temperature in aqueous 5M perchloric acid and in 0.010 to 0.20M perchloric acid solutions in water–dioxane (mole fraction of dioxane (Z) = 0, 0.048, 0.12, and 0.23). In the solvents with Z = 0.12 and 0.23, pathways involving perchlorate ion play an important role in the exchange reaction. Activation parameters (for electrolyte-free solution) are $\Delta H^{\ddagger} = 6.2$ kcal mol^{-1} and $\Delta S^{\ddagger} = -37$ cal mol^{-1} deg^{-1} at Z = 0, and $\Delta H^{\ddagger} = 7.9$ kcal mol^{-1} and $\Delta S^{\ddagger} = -33$ cal mol^{-1} deg^{-1} at Z = 0.048. (auth)

29245 EXCHANGE OF CHROMIUM BETWEEN CHROMIUM(II) AND FUMARATOCHROMIUM(III) AND RELATED REACTIONS. Diaz, H.; Taube, H. (Stanford Univ., Calif.). Inorg. Chem.; 9: 1304–11(Jun 1970).

The reactions of chromous ion with fumaratopentaaquochromium(III), cis-fumaratoaquotetraamminecobalt(III), and cis-fumaratoaquobis(ethylenediamine)cobalt(III) were studied. For the last complex the rate law has the form $-d[Cr^{2+}]/dt = (k_{-h}'[H^+]^{-1} + k_0 + k_h'[H^+])[Cr^{2+}][Oxid]$, while for the first two complexes, the k_{-h}' and k_0 terms suffice to express the variation of rate with $[H^+]$ in the range 0.1 to 1.0 M. The values of k_0 at 25°C for the three complexes, respectively, are ~3, 61, and 9.1 M^{-1} sec^{-1}. The relative insensitivity of rate to change in identity of the oxidizing agent is taken as indicating a stepwise mechanism for electron transfer. It is inferred that the activated complex corresponding to the k_{-h}' term is doubly bridged with OH^- and the adjacent carboxyl of the fumarate serving as bridging groups. The role of the proton in the k_h' term is interpreted as that of stabilizing the radical intermediate derived from the fumarate. This interpretation does not make obvious, however, why the k_h' term appears for one cobalt complex but not the other. (auth)

29246 VIBRATIONAL SPECTRA, VIBRATIONAL ANALYSIS, AND BONDING IN ACETONITRILE–BORON TRIFLUORIDE. Swanson, B.; Shriver, D. F. (Northwestern Univ., Evanston, Ill.). Inorg. Chem.; 9: 1406–16(Jun 1970).

Infrared and Raman data in the 4000 to 70-cm^{-1} region were determined at –196°C for five isotopic species of F_3BNCCH_3. Also, vibrational data were obtained for 3% F_3BNCCH_3 in host crystals of F_3BNCCD_3. Several interesting temperature- and host-dependent features were observed. The foregoing in conjunction with Raman polarization data for the complex in solution form the basis of assignments. Normal-coordinate calculations based on a constrained general-valence force field aid in assigning the low-frequency region. The frequencies and force constants are discussed in terms of donor-acceptor interaction. (auth)

29247 BORON–NITROGEN COMPOUNDS. XXXIII. A NORMAL-COORDINATE ANALYSIS OF BORAZINE. Blick, Kenneth E.; Dawson, John W.; Niedenzu, Kurt (Univ. of Kentucky, Lexington. Army Research Office, Durham, N. C.). Inorg. Chem.; 9: 1416–21(Jun 1970).

Utilizing a recent reassignment of the vibrational spectrum of borazine, $(-BH-NH-)_3$, and isotopically labeled derivatives thereof, a normal-coordinate analysis on this six-membered heterocycle was performed. The calculated valence force field was adjusted to provide a good fit for all of the available data. When the entire set of suggested assignments for the normal vibrations of $(-BH-NH-)_3$, $(-{}^{10}BH-NH-)_3$, $(-BH-ND-)_3$, $(-{}^{10}BH-ND-)_3$, $(-BD-NH-)_3$, $(-{}^{10}BD-NH-)_3$, and $(-BD-ND-)_3$ was utilized in a simultaneous least-squares adjustment, the average error between all of the calculated and observed frequencies was 1.01%. The calculated force constants were in agreement with recent judgments on the strength of the various bonds in the borazine molecule. The calculated potential energy distribution of the isotopically labeled derivatives indicated that the character of several BH and NH vibrations is altered substantially on deuteration at either the boron or the nitrogen atoms. Displacements calculated for the parent borazine molecule reveal appreciable movement of the annular atoms out of the molecular plane. (auth)

29248 KINETICS AND MECHANISM OF TRIMETHYLAMINE–HALOBORANE HYDROLYSIS. Lowe, John R.; Uppal, Surjit S.; Weidig, Charles; Kelly, Henry C. (Texas Christian Univ., Fort Worth). Inorg. Chem.; 9: 1423–7(Jun 1970).

The rates of solvolysis of trimethylamine–monohaloboranes in aqueous dioxane at 25°C increased in the series $(CH_3)_3NBH_2Cl < (CH_3)_3HBH_2Br < (CH_3)_3NBH_2I$. The diiodoborane adduct reacted more slowly than the monoiodo compound but faster than trimethylamine–borane. Only a very slight retardation in rate was observed on substitution of deuterium for hydrogen on boron in the diiodo derivative ($k_H/k_D = 1.1$); however, a noticeable solvent isotope effect ($k_{H_2O}/k_{D_2O} = 1.8$) is observed for hydrolysis of both the mono- and diiodoborane adducts in 67% aqueous dioxane at 25°. Rates increased with increasing water content of the aqueous dioxane solvent system. No significant effect on rate of acidity is seen for hydrogen ion concentrations as high as 0.3 M or hydroxide ion concentrations up to 0.1 M, nor is the rate appreciably affected by the addition of potassium chloride or potassium iodide up to 0.3 M. The results indicate a mechanism for hydrolysis of the halo compounds quite different from that postulated for amine–BH_3 adducts. It is proposed that a rate-determining cleavage of a boron–halogen bond is followed by rapid collapse of an incipient boron(1+) ion. An analogy to nucleophilic substitution reactions in haloborane–amines leading to kinetically stable boronium ions is suggested. (auth)

29249 HETEROGENEOUS ISOTOPE EXCHANGE BETWEEN IRON AND DISSOLVED IRON IONS. Lieser, K. H.; Krueger, A. (Technische Hochschule, Darmstadt, Ger.). Z. Phys. Chem. (Frankfurt); 68: 185–93(Dec 1969). (In German).

The heterogeneous exchange of ^{59}Fe between metallic iron and iron ions was investigated in relation to time and iron ion concentration. At room temperature less than 0.05 atomic layers of the metal surface exchanged, indicating practically no isotope exchange under these conditions. (M.C.G.)

29250 VIBRATIONAL SPECTRA AND STRUCTURES OF IONIC LIQUIDS. IV. ISOTOPIC DILUTION OF THE ALKALI METAL AND AMMONIUM NITRATES. Devlin, J. Paul; Li, Paul C.; Pollard, Gary (Oklahoma State Univ., Stillwater). J. Chem. Phys.; 52: 2267–73(1 Mar 1970).

The isotopic isolation of the $^{14}NO_3^-$ ion in molten $Li^{15}NO_3$ was found to produce a 3-cm^{-1} increase in the ν_2 (out-of-plane) frequency. This is interpreted as the result of the decoupling of $^{14}NO_3^-$ ions in a perturbed lattice structure. The shift direction and magnitude resembles that observed on isotopic decoupling of ions in solid $LiNO_3$ and $NaNO_3$. This comparison, plus the recently reported similarity between the far-infrared phonon spectrum of solid and molten $NaNO_3$, is contrasted with other spectroscopic observations that suggest a substantial structural modification on melting. For example, a 50% ^{15}N lithium nitrate sample displayed an infrared $\acute{e}_2$ intensity anomaly, which is thought to be characteristic of a stacked (orthorhombic) structure. It is suggested that most spectral features that seem to indicate substantial structural change on melting may merely reflect the inevitable reduction in the symmetry of the cation field at the anion site as a consequence of cation vacancies. The Ir and Raman spectra of NH_4NO_3 and ND_4NO_3 were also determined guided by the assumption that ammonium nitrate would represent the limiting case of weak cation–anion interaction in ionic melts. However, the data indicate some distortion of both polyatomic ions, but, in contrast to the alkali metal nitrates, no evidence for anion–anion or cation–cation dynamical coupling has been detected. (auth)

29251 ROTATIONAL CORRELATION TIMES IN CHLOROFORM AND METHYL CHLOROFORM. Hogenboom, D. L.; O'Reilly, D. E.; Peterson, E. M. (Argonne National Lab., Ill.). J. Chem. Phys.; 52: 2793–4(1 Mar 1970).

Nuclear rotational correlation times were measured for ^{35}Cl and D in chloroform and 1.1.1-trichloroethane along with the coefficient of self-diffusion. (M.C.G.)

29252 SOLID-STATE REACTION BETWEEN U_3O_8 AND 3MgO. Negro, Alfredo; Amato, Ignazio (Politecnico, Turin). Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 103: 375–96(Mar–Apr 1969). (In Italian).

The U_3O_8–3MgO system was studied using differential thermal analysis and x-ray diffraction. The thermal analysis showed that during the heating up to 1400°C, three endothermal phenomena were detected at 1040°, 1200°, and 1265°C; during the cooling from 1400°C, two exothermal effects were detected at 1140 and 1090°C. In tempering of the heated mixture at successive times, the first compound formed is hexagonal MgU_3O_{10}, which with time or at higher temperatures (900 to 1200°C) reacts with further quantities of MgO to give rhombic $MgUO_4$. In the temperature interval from 1200 to 1265°C, $MgUO_4$ loses oxygen to form $MgUO_{3.5}$ with fluorite structure; the transformation in air is reversible by which, dur-

ing cooling, the rhombic phase is restored. The presence of two doublets was shown by the spectrograms of $MgUO_4$, whereas the preceding literature reports a single interference. (tr-auth)

29253 INFRARED AND RAMAN INVESTIGATION OF CONDENSED PHASES OF METHYLAMINE AND ITS DEUTERIUM DERIVATIVES. Wolff, H. (Univ., Heidelberg). J. Chem. Phys.; 52: 2800-2(1 Mar 1970).

Investigations of the Raman and ir spectra of condensed CH_3NH_2 and CH_3ND_2 are summarized. They show the stretching vibrations of NH, ND, and CH. (M.C.G.)

29254 ORGANOMAGNESIUM COMPOUNDS AS REDUCING AGENTS. II. ISOTOPE EFFECT IN THE REDUCTION OF KETONES. Chauviere, Gerard; Welvart, Zoltan (Centre National de la Recherche Scientifique, Thiais, France). Bull. Soc. Chim. Fr.; No. 2, 765-70(Feb 1970). (In French).

Isotope effects in the reduction of ketones by organomagnesium compounds are measured by two methods. In the first one, a mixture of ^1H and ^2H organomagnesium compounds is used; the isotope effect is deduced from the deuterium content of the products of reduction and of addition. In the second one, the ratio of reduction/addition products is measured separately for the hydrogenated and the deuterated organomagnesium substrates. These two methods lead to different isotope effects. The reaction between organomagnesium compounds and ketones may involve at least two types of reagents: RMgX and RMgX' (X' being the alcoholate obtained during the reaction). These two types of organomagnesium compounds react during the various consecutive steps. (France)

29255 ORGANOMAGNESIUM COMPOUNDS AS REDUCING AGENTS. III. ISOTOPE EFFECT IN THE 1-4 REDUCTION OF ALKYLIDENE MALONATES AND CYANOACETATES. Chauviere, Gerard; Welvart, Zoltan (Centre National de la Recherche Scientifique, Thiais, France). Bull. Soc. Chim. Fr.; No. 2, 771-4(Feb 1970). (In French).

Two methods, previously used for the determination of isotope effects in the reduction of ketones (Bull. Soc. Chim. Fr., No. 2, 765-770(1970)), give similar results for alkylidene malonates and cyanoacetates. (France)

29256 ORGANOMAGNESIUM COMPOUNDS AS REDUCING AGENTS. IV. STERIC ISOTOPE EFFECT. Chauviere, Gerard; Welvart, Zoltan (Centre National de la Recherche Scientifique, Thiais, France). Bull. Soc. Chim. Fr.; No. 2, 774-9(Feb 1970). (In French).

Isotope effects are measured in the reduction, by isobutylmagnesium chloride, of 4-8-butylcyclohexanone, of its dimethylimmonium salt, and of the corresponding cyclohexylidene ethyl cyanoacetate. When the value of the isotope effect increases, the yield of trans-isomer obtained decreases. A shorter distance between the two reagents in the transition state during reduction is found to correspond to an increased isotope effect. The isotope effects in the formation of cis- and trans-isomers are different. This is in agreement with the interpretation whereby the attack angle of the reducing agent is not the same in the two diastereoisomeric transition states. (France)

29257 MICROWAVE SPECTRUM OF METHYLENE FLUORIDE. CENTRIFUGAL DISTORTION AND MOLECULAR STRUCTURE. Hirota, Eizi (Kyushu Univ., Fukuoka); Tanaka, Takehiko; Sakakibara, Akira; Ohashi, Yukako; Morino, Yonezo. J. Mol. Spectrosc.; 34: 222-30(May 1970).

The microwave spectra of CH_2F_2 and CD_2F_2 were investigated in detail to determine the centrifugal distortion constants: τ_{aaaa} = -2.3049 ± 0.0041, $\tau_{bbbb} = -0.06064 \pm 0.00091$, $\tau_{cccc} = -0.02653 \pm 0.00071$, $T_1 = 0.170 \pm 0.012$, and $T_2 = -0.03648 \pm 0.00099$ MHz for CH_2F_2 and $\tau_{aaaa} = -0.865 \pm 0.011$, $\tau_{bbbb} = -0.0530 \pm 0.0017$, $\tau_{cccc} = -0.0268 \pm 0.0015$, $T_1 = 0.036 \pm 0.016$, and $T_2 = -0.0327 \pm 0.0018$ MHz for CD_2F_2. The molecular structure determined using rotational constants of the four isotopic species is $r(C-H) = 1.093_4 \pm 0.003$ Å, $r(C-F) = 1.357_4 \pm 0.001$ Å, $\theta(\angle HCH) = 113°40' \pm 10'$, $\theta(\angle FCF) = 108°19.0' \pm 3'$. (auth)

29258 ELECTRONIC SPECTRA AND STRUCTURE OF THE HYDROGEN HALIDES. THE $b^3\Pi_i$ AND $C^1\Pi$ STATES OF HBr AND DBr. Ginter, M. L. (Univ. of Maryland, College Park); Tilford, S. G. J. Mol. Spectrosc.; 34: 206-21(May 1970).

The absorption spectra of HBr and DBr below 1515Å were rephotographed at high resolution. Analyses of the "B" $-$ X and C $-$ X transitions show that the "B" and C states are the $\Omega = 1$ components of a $^3\Pi_i$ (designated here as b) and a $^1\Pi$ state, respectively. Both states originate from the same $\pi^3\sigma$ configuration. The coupling in these states is intermediate between A, S and Ω, ω and small tendencies toward Case c are present. Both the b and C states exhibit strong predissociations. Effective molecular constants are presented for the b and C states of HBr and DBr. (auth)

29259 ELECTRONIC SPECTRA AND STRUCTURE OF THE HYDROGEN HALIDES. THE $b\ ^3\Pi_i$ AND $C\ ^1\Pi$ STATES OF HI AND DI. Tilford, S. G. (Naval Research Lab., Washington, D. C.); Ginter, M. L.; Bass, Arnold M. J. Mol. Spectrosc.; 34: 327-40 (May 1970).

The absorption spectra of HI and DI below 1900 Å were photographed at high resolution. Analyses of the "B" $\leftarrow$ N and C $\leftarrow$ X transitions show that the "B" state is the $^3\Pi_i$ component of a $^3\Pi_i$ state (designated here as b) and the C state is a $^1\Pi$ state. Both b $^3\Pi_i$ and C $^1\Pi$ originate from the same $\pi^3\sigma$ configuration, exhibit strong predissociations, and show some small Case c effects. The transition from approximately Λ, S toward Ω, ω coupling is discussed for the b and C states of the hydrogen halides, HCl, DCl, HBr, DBr, HI, and DI. Effective molecular constants are presented for the b and C states of HI and DI. (auth)

29260 CLASSIFICATION, REPRESENTATION, AND PREDICTION OF CRYSTAL STRUCTURES OF IONIC COMPOUNDS. Gorter, E. W. (Leiden Univ.). J. Solid State Chem.; 1: 279-305(Apr 1970).

With the aid of a qualitative model of ionic bonding, including polarizability, many crystal structures, mainly of halides and chalcogenides, can be explained or even predicted. Polarization of O^{2-} and F^- ions may be neglected unless these ions have very small, or small and highly charged cation neighbours. The polarizability of a few large cations is assumed also to play a role. The cation polyhedron may have a shape different from that expected for the ionic model as a result of nonionic bonding types; the theoretical shapes can be used empirically in the structure prediction. The background of this ionic picture and the sharing of corners and/or edges and/or faces of cation polyhedra are considered. A classification of crystal structures is given in plots of cation coordination versus stoichiometry, expressed as the ratio nr. anions/nr. cations, for simple compounds and complex anions. The average cation coordination is plotted against stoichiometry if one is interested in the changes of structure under high pressure. Description of crystal structures by space-filling polyhedra is presented. Simple structures with close packed anions or cations are explained by the ionic model. Some structure predictions (e.g., of Sc_2S_3, Li_2CuO_2, $SrCuO_2$, Sr_2CuO_3, and $SrCu_2O_2$) are discussed, and some results of recent structure determinations (Sr $-$ Cu $-$ O $-$ compounds, β-$BaPdO_2$, $MgAl_2S_4$, $FeAl_2S_4$ and $MgGa_2S_4$) are given. (auth)

29261 ISOTOPIC EXCHANGE OF OXYGEN ^{18}O BETWEEN THE GASEOUS PHASE AND OXIDE CATALYSTS. Novakova, J. (Inst. of Physical Chemistry, Prague). Catal. Rev.; 4: 77-114 (1970).

The isotopic exchange of ^{18}O between gaseous oxygen and solids is reviewed under the following headings: theory, summary of experimental data, results, discussion, and conclusions. (142 references). (M.C.G.)

29262 USE OF MOLECULAR BEAMS IN THE STUDY OF CATALYTIC SURFACES. Merrill, Robert P. (Univ. of California, Berkeley). Catal. Rev.; 4: 115-59(1970).

The present state of theory and experiment on the scattering of atomic and molecular beams from surfaces is described. Surface preparation and beam generation and detection are discussed. Both reactive and nonreactive scattering are considered. Among the results studied are H, D, and He scattering from Ni and H $-$ D exchange on nickel. (78 references). (M.C.G.)

29263 NORMAL AND SOLVATED CHELATES OF SEXIVALENT ACTINIDES WITH α-PICOLINIC ACID. Eberle, S. H.; Robel, W. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Inorg. Nucl. Chem. Lett.; 6: 359-65(Apr 1970). (In German).

The method described previously [NSA 22: 16513] was used to prepare and analyse normal and solvated chelates of U, Np, Pu, and Am. Thermogravimetric curves are shown and interpreted. Absorption spectra of the U and Pu compounds are compared, and were further analysed by computer to give stability constant values. The sequence of formation of the various chelates of each actinide is discussed. (U.K.)

29264 ISOTOPIC EXCHANGE OF OXYGEN ON SILVER-GOLD ALLOY LAYERS. Starostina, T. S.; Khasin, A. V.; Boreskov, G. K.; Plyasova, L. M. (Inst. of Catalysis, Novosibirsk, USSR). Dokl. Akad. Nauk SSSR; 190: 394-7(11 Jan 1970). (In Russian).

Gold and silver have similar crystal structures with nearly identical lattice dimensions; it may be assumed that in their alloys the Fermi level will decrease uniformly from Ag to Au and, therefore, the adsorption energy of oxygen should also decrease, following changes in reactivity. This problem was investigated by determining the reaction rate of the homomolecular isotopic ex-

change of oxygen and the exchange between the adsorbed and gaseous oxygen, using a static vacuum system connected to a mass spectrometer by means of a capillary. The alloy layers were prepared by the simultaneous evaporation of the two metals, liquid drop of an induction-heated alloy. The results indicated that the reactivity of the oxygen on the Ag–Au alloys is higher than on silver. The exchange rate on silver depends on the desorption probability of the oxygen from the surface of the metal. The presence of gold atoms decreases the adsorption energy of oxygen on the silver atoms, thus facilitating the desorption process and increasing the exchange rate. It is concluded that surface silver atoms play a decisive role in the isotopic exchange of oxygen. (TTT)

29265 VAPORIZATION OF FISSION PRODUCTS FROM IRRADIATED URANIUM. II. SOME OBSERVATIONS ON THE CHEMICAL BEHAVIOR OF FISSION PRODUCTS IODINE AND CESIUM. Castleman, A. W. Jr.; Tang, I. N. (Brookhaven National Lab., Upton, N. Y.). J. Inorg. Nucl. Chem.; 32: 1057-64 (Apr 1970).

The results of an experimental investigation of the chemical nature of fission product iodine and cesium vaporized from irradiated uranium specimens into helium and air are reported. The thermochromatographic technique, which was described in detail in the first paper of the present series, was employed in the study. It was observed that iodine released from uranium heated to 1250°C in helium was not in chemical combination with either cesium or any other fission product, but was vaporized as a uranium–iodine compound. Partial dissociation of this compound into atomic iodine occurred when the uranium was heated to temperatures above 1900°C. In an oxidizing atmosphere only elemental iodine was vaporized. (auth) (UK)

29266 KINETICS AND MECHANISM OF AQUATION OF CARBONATO COMPLEXES OF COBALT(III). III. THE ACID-CATALYZED AQUATION OF SOME CARBONATOBIS(DIAMINE) COBALT(III) COMPLEXES. Sastri, V. S.; Harris, G. M. (State Univ. of New York, Buffalo). J. Amer. Chem. Soc.; 92: 2943-6 (20 May 1970).

Examinations were made of the aquation of the complex ions $CoN_4CO_3^+$, where N_4 ≡ $(en)_2$, $(pn)_2$, or $(tn)_2$ (en ≡ ethylenediamine, pn ≡ propylenediamine, and tn ≡ trimethylenediamine). The kinetics and mechanism appear to be identical over the range $1 < pH < 5$ with those of the tetraammine analog ($N_4 \equiv (NH_3)_4$), for which the experimental rate constant is given by $k = k_0 + k_1[H^+]$, as previously reported. The values of the rate parameters for the water-catalyzed part of the process are the same within the inescapably large experimental error for all four complexes, with $k_0 \cong 1 \times 10^{-4}$ sec^{-1}, $\Delta H_0^{\ddagger} \cong 16$ kcal/mol, and $\Delta S_0^{\ddagger} \cong -20$ eu. The acid-catalyzed reactions show some small but significant differences such that k_1 is a little smaller at 25° for the $(en)_2$ and $(pn)_2$ species (0.5 $\underline{M}^{-1}$ sec^{-1}) than for $(tn)_2$ (0.8 $\underline{M}^{-1}$ sec^{-1}), and only about one-third as large as for the tetraammine(1.5 $\underline{M}^{-1}$ sec^{-1}), though the other rate parameters are not far apart. Deuterium solvent isotope effect studies confirm the earlier conclusion that these aquations involve a rate-determining proton transfer rather than a proton-preequilibration mechanism. (auth)

29267 RESTRICTED INTERNAL ROTATION IN CATION RADICALS DERIVED FROM AMINOETHYLENES. AN ELECTRON SPIN RESONANCE INVESTIGATION. Gilbert, Bruce C.; Schlossel, Richard H.; Gulick, Wilson M. Jr. (Cornell Univ., Ithaca, N. Y.). J. Amer. Chem. Soc.; 92: 2974-82(20 May 1970).

Three closely related cation radicals were studied by electron spin resonance spectroscopy. These radicals were obtained by one-electron oxidation of 1,2-bis(dimethylamino)ethylene, 1,2-bis (dimethylamino)ethylene-[$^2H_{12}$], and 1,2-bis(diethylamino)ethylene, respectively. At 25°C all 12 methyl protons in the 1,2-bis(dimethylamino)ethylene cation radical are magnetically equivalent, whereas at –70°C and below two inequivalent groups of six protons each are observed. These observations were interpreted in terms of restriction of rotation about the bonds between the ethylenic carbons and the amine nitrogens. The deuterated radical exhibits an interesting isotope effect: the deuterons exist in two magnetically inequivalent groups of six in the temperature range from 35 to –30°C. This result indicates that rotation about the carbon–nitrogen bonds is at least tenfold slower in the deuterated radical than in the protio radical. The inequivalence of two sets of methylene protons in the 1,2-bis(diethylamino)ethylene cation is maintained over the range of temperatures 60 to –70°C. Also examined was the ESR spectrum of the cation radical derived from perdeuteriotetrakis(dimethylamino)ethylene, a radical previously studied by Kuwata and Geske, and have resolved the two different deuterium coupling constants. The α_H/α_D ratios obtained from the tetrakis(dimethylamino)ethylene cations and the bis(dimethylamino) ethylene cations are compared and found to be similar. (auth)

29268 STUDIES ON NITROGEN-COORDINATED COMPLEXES. PREPARATIONS AND REACTIONS OF HYDRIDO-PHOSPHINE COMPLEXES OF RUTHENIUM AND RHODIUM. Ito, Takashi; Kitazume, Shoji; Yamamoto, Akio; Ikeda, Sakuji (Tokyo Inst. of Tech.). J. Amer. Chem. Soc.; 92: 3011-16 (20 May 1970).

Tetrakis(triphenylphosphine)ruthenium dihydride, $H_2Ru(PPh_3)_4$, and tetrakis(triphenylphosphine)rhodium hydride, $HRh(PPh_3)_4$, were synthesized. Both light yellow complexes were characterized by means of elemental analyses, thermal decompositions, infrared spectroscopy, and other chemical reactions. $H_2Ru(PPh_3)_4$ was found to dissociate in solution into free triphenylphosphine and $H_2Ru(PPh_3)_3$, and the reversible combination of $H_2Ru(PPh_3)_3$ with N_2 and H_2 was demonstrated. In the exchange reaction with deuterium, 24 to 25 hydrogens per mole of the ruthenium complex were found to participate, indicating the reversible exchange of all the ortho hydrogens of phenyl groups with deuterium, whereas in the rhodium complex, the number of exchangeable hydrogens was about seven to nine. (auth)

29269 KINETIC STUDY OF THE OXIDATION OF THALLIUM(I) BY NEPTUNIUM(VII). Thompson, R. C.; Sullivan, J. C. (Argonne National Lab., Ill. Univ. of Missouri, Columbia). J. Amer. Chem. Soc.; 92: 3028-30(20 May 1970).

The empirical form of the rate law for the reaction between Np(VII) and Tl(I) in acid perchlorate media is $-d[Np(VII)]/dt = k'[Np(VII)][Tl(I)]$, where $\ln k' = \ln k + n \ln [H^+]$. At 25°C in 1 $\underline{M}$ perchloric acid $k = 4.46 \pm 0.04$ $\underline{M}^{-1}$ sec^{-1} and $n = 0.901 \pm 0.008$. The apparent activation energy is 7.73 ± 0.42 kcal/mol. Results of ^{18}O tracer studies are presented. (auth)

29270 KINETIC ISOTOPE EFFECTS IN THE AQUEOUS ETHANOLYSIS OF DEUTERATED CYCLOPENTYL BROSYLATES. Stoffer, J. O.; Christen, J. D. (Univ. of Missouri, Rolla). J. Amer. Chem. Soc.; 92: 3190-1(20 May 1970).

Results of product analysis of the solvolysis mixture by gas chromatography are given. Kinetic data showed a larger isotope effect for the trans isomer than for the cis isomer. Thus the idea of specific solvation of the β hydrogens cannot be ruled out as a contributing factor to secondary isotope effects. (M.C.G.)

29271 HYDROGEN PARTICIPATION IN OPEN-CHAIN ARENESULFONATE SOLVOLYSIS. Shiner, V. J. Jr.; (Indiana Univ., Bloomington); Stoffer, J. O. J. Amer. Chem. Soc.; 92: 3191-2(20 May 1970).

The effect of substitution of deuterium for the β hydrogens on the rate of solvolysis of 3-pentyl brosylate and 2,4-dimethyl-3-pentyl brosylate was investigated. For 3-pentyl brosylates, successive deuterium substitution led to cumulative isotope effects, which is explained by hyperconjugation. For 2,4-dimethyl-3-pentyl brosylates, successive deuterium substitution did not lead to cumulative isotope effects. This is explained in terms of neighboring participation in the solvolytic transition state. (M.C.G.)

29272 POLYMORPHISM OF ANHYDROUS URANYL ACETATE. II. Giorgio, Gerard; Mentzen, Bernard; Breysse, Michele; Claudel, Bernard (Institut National des Sciences Appliquees, Lyon). J. Inorg. Nucl. Chem.; 32: 1517-24(May 1970). (In French).

Five distinct allotropic species of anhydrous uranyl acetate were detected by differential enthalpic analysis, and were further studied by x-ray diffraction and ir spectrophotometry. (auth) (UK)

29273 FAR-INFRARED SPECTRA AND LATTICE VIBRATIONS OF BARIUM CHLORIDE DIHYDRATE. Fukushima, Kunio; Kataiwa, Hiroaki (Shizuoka Univ., Japan). Bull. Chem. Soc. Jap.; 43: 690-7(Mar 1970).

The far infrared spectra of barium chloride dihydrate and its deutero analog were measured in the region of 60 to 4000 cm^{-1}. The assignment of the infrared bands due to crystal water and crystal heavy water was made on the basis of the band frequency shift associated with deuteration. The optically active lattice vibrations were calculated in order to assign the far infrared bands and elucidate the nature of the vibrations. (auth)

29274 MOLECULAR VIBRATIONS AND FORCE FIELDS OF DIMETHYL SELENIDE AND DIMETHYL SELENIDE-d_6. Shiro, Yuji; Ohsaku, Masaru; Hayashi, Michiro; Murata, Hiromu (Hiroshima Univ.). Bull. Chem. Soc. Jap.; 43: 619-22(Mar 1970).

A set of the modified Urey–Bradley force constants and of the local symmetry force constants of dimethyl selenide were calculated by a least-squares technique, using the vibrational frequencies of the two isotopic species, $(CH_3)_2Se$ and $(CD_3)_2Se$. The calculated frequencies thus obtained are in good agreement with the observed values. The force constants for dimethyl ether, dimethyl sulfide, and dimethyl selenide were compared. A relationship among the force constant, bond length, bond angle, and atomic

number of the central atom was found. The centrifugal distortion constants, which were calculated from the two sets of force constants, were then compared with those obtained from the microwave spectra; their values are found to be consistent with those obtained from a microwave study in a three-body approximation. (auth)

29275 VIBRATIONAL SPECTRA AND FORCE CONSTANTS OF URANIUM TETRAFLUORIDE. Krasser, W.; Nuernberg, H. W. (Kernforschungsanlage, Juelich, Ger.). Spectrochim. Acta, Part A; 26: 1059-62(May 1970).

The Raman and ir spectrum of crystalline UF_4 was recorded and the force constants of the valence force field and of the Urey–Bradley force field calculated on the basis of the tetrahedral symmetry T_d. (auth) (UK)

29276 LATTICE VIBRATIONS OF δ-URANIUM AND TUNGSTEN TRIOXIDES. Ohwada, K. (Japan Atomic Energy Research Inst., Ibaraki). Spectrochim. Acta, Part A; 26: 1035-44(May 1970).

The infrared spectra of δ-uranium and tungsten trioxides were measured in the frequency region from 4000 to 380 cm^{-1}. The GF matrix method was applied to the analysis of lattice vibrations. By assuming the simple and modified valence force fields for the previously determined crystal structure of the trioxides, frequencies of the two infrared-active lattice vibrations were calculated. On the basis of these calculations, three bands observed for the trioxides are reasonably assigned either to infrared-active fundamentals or to combination tones. The force constants obtained for δ-uranium trioxide are also discussed. (auth) (UK)

29277 NATURE OF THE PRECIPITATED AMORPHOUS OXIDES OF THE ELEMENTS OF GROUP IV A. II. STUDY BY PROTON NUCLEAR MAGNETIC RESONANCE. Vivien, Daniel; Livage, Jacques; Mazieres, Charles; Gradsztajn, Sonia; Conard, Jacques (Ecole Nationale Superieure de Chimie, Paris. Paris Univ.). J. Chim. Phys.; 67: 205-13(Jan 1970). (In French).

Nuclear magnetic resonance studies of the protons in amorphous precipitated oxides of Ti, Zr, Hf, and Th support previous results: these compounds are hydroxides, $MO_{2-x}(OH)_{2x} \cdot yH_2O$. They contain OH groups bonded to the metal atom, and water molecules adsorbed on the surface or in the porosity of the solid. From Ti to Th, x values increase, and the proton–proton distance decreases. For a given oxide, drying and aging lead to a condensation of OH groups and give the hydrated oxide form. (France)

29278 THERMAL DECOMPOSITION OF NEPTUNIUM(IV) OXALATE. Lindsay, John W.; Robinson, Herbert N.; Bramlet, Harvey L.; Johnson, Andrew J. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Inorg. Nucl. Chem.; 32: 1559-67(May 1970).

Differential thermal analysis, thermogravimetric analysis, and effluent gas analysis were used to investigate the thermal decomposition of neptunium(IV) oxalate hexahydrate. X-ray diffraction data on the hexa- and dihydrated oxalates are given, along with ir spectra of the hexahydrated oxalate. (auth) (UK)

29279 NITROGEN ISOTOPE EFFECT STUDY OF AN AROMATIC NUCLEOPHILIC SUBSTITUTION REACTION. Ayrey, G.; Wylie, W. A. (Queen Elizabeth Coll., London). J. Chem. Soc., B; No. 4, 738-9(1970).

Hydrolysis of p-nitroaniline in aqueous sodium hydroxide was found to be second order with an activation energy of 17 kcal/mole and an entropy of activation of ca.-33 e.u. Absence of a significant nitrogen isotope effect for the reaction established that C—N bond stretching was unimportant in the rate-determining transition state. (auth) (UK)

29280 MECHANISM OF SOLVOLYSIS OF 2-HALOGENOALKYLSILANES. PART II. DEUTERIUM ISOTOPE EFFECTS. Jarvie, A. W. P.; Holt, A.; Thompson, J. (Univ. of Aston, Birmingham, Eng.). J. Chem. Soc., B; No. 4, 746-8(1970).

The compounds $Me_3Si{\cdot}CH_2{\cdot}CD_2Br$, $Me_3Si{\cdot}CHD{\cdot}CH_2Br$, and $(CD_3)_2MeSi{\cdot}CH_2{\cdot}CH_2Br$ were prepared and their solvolysis rates in aqueous ethanol were determined and compared with those for the nondeuteriated compounds. The acid-catalyzed solvolysis of the 2-hydroxyalkylsilanes is similar to the solvolysis of 2-halogenoalkylsilanes and it appears likely that it follows a similar mechanism. The compound $Me_3Si{\cdot}CH_2{\cdot}CD_2{\cdot}OH$ was prepared and its rate of solvolysis was determined and compared with that of the non-deuteriated material in the same medium. The mechanism of the solvolysis reaction is discussed in the light of the observed isotope effects and the stereochemical evidence reported previously. (auth) (UK)

29281 SECONDARY DEUTERIUM ISOTOPE EFFECTS FOR HYDROLYSIS OF ACETALS AND ORTHOFORMATES. Bull, H.; Pletcher, T. C.; Cordes, E. H. (Indiana Univ., Bloomington). J. Chem. Soc., D; No. 9, 527-8(6 May 1970).

Kinetic secondary deuterium isotope effects for the hydrolysis of ethyl orthoformate and propionaldehyde diethylacetal reveal that the transition state resembles the substrate in the former case and the carbonium ion intermediate in the latter; for substituted benzaldehyde diethylacetal hydrolysis, the transition states increasingly resemble the carbonium ion intermediates as the electron withdrawing power of the polar substituent increases. (auth) (UK)

29282 MECHANISM OF THE H_2–D_2 EXCHANGE REACTION OVER ZnO. DYNAMIC BEHAVIOR OF CHEMISORBED HYDROGEN AS A REACTION INTERMEDIATE DURING THE COURSE OF THE REACTION. Naito, Shuichi; Shimizu, Hazime; Hagiwara, Etsuko; Onishi, Takaharu; Tamaru, Kenzi (Tokyo Univ.). Bull. Chem. Soc. Jap.; 43: 974(Mar 1970).

The mechanism of the H_2-D_2 exchange reaction over ZnO at −70°C to room temperature was studied by measuring adsorption during the course of the reaction by volumetric and infrared spectroscopic methods. No isotope effect was involved in the chemisorption, but a considerable kinetic isotope effect was observed in the rate of the exchange reaction. Results indicated that the rate of the HD formation from the recombination of the chemisorbed species, which corresponds to the desorption rate, is at least one or two orders of magnitude slower than the exchange reaction between molecular hydrogen in the ambient gas and the chemisorbed species. (J.G.B.)

29283 COMPLEXES FORMED IN AQUEOUS SOLUTIONS OF DIMETHYLSUCCINIC ACID WITH URANYL ION. Campi, E.; Vanni, A. (Istituto de Chimica Analitica, Turin). Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 104: 99-110(Jan-Feb 1970). (In Italian).

The complexes formed in aqueous solutions of the uranyl ion with the (a–a′)d–l, (a–a′)meso, and (a–a) dimethylsuccinic acids were studied potentiometrically at ion strengths of 1F (KNO_3) and a temperature of 25 ± 0.5°C. The results, obtained from solutions containing uranyl ions in the stoichiometric ratio 1:1 show that the stability of the complexes, either of the MA or MHA type, decreases in going from the disubstituted (a–a) acid to the (a–a′) acids. In the presence of the d–l form and (a–a), the formation of oxyhydrate species of the MA(OH) type is found. The values of the equilibrium constant are reported and discussed with reference to succinic acid. (tr-auth)

29284 STABILITY CONSTANTS IN AQUEOUS SOLUTION OF COMPLEXES OF URANYL ION WITH MIXED DIBASIC ACIDS. Ramamoorthy, S.; Santappa, M. (Univ. of Madras). J. Inorg. Nucl. Chem.; 32: 1623-9(May 1970).

Systems of uranyl ion–succinic–adipic, uranyl ion–succinic–thiomalic, and uranyl ion–succinic–itaconic acids were studied by pH titration method at $\mu = 0.1$ ($NaClO_4$) and T = 31°C. The formation of 1:1:1 complexes was inferred from the titration curves and their stability constants are reported. (auth) (UK)

29285 CHARACTERISATION OF URANYL ACETATE DIHYDRATE IN THE SOLID STATE. Mentzen, Bernard; Giorgio, Gerard (Laboratoire de Cinetique Chimique, Villeurbanne, France). J. Inorg. Nucl. Chem.; 32: 1509-16(May 1970). (In French).

Some structural properties of uranyl acetate dihydrate were studied by differential enthalpic analysis, x-ray diffraction and ir spectroscopy. The lattice parameters were precisely determined and a probable structural pattern is given. (auth) (UK)

29286 STUDY OF THE WATER DISSOLVED IN AROMATIC SOLVENTS BY INFRARED SPECTROSCOPY. Gentric, Emile; Le Narvor, Anne; Saumagne, Pierre (Brest Univ., France). Compt. Rend., Ser. C; 270: 1053-6(23 Mar 1970). (In French).

The analysis of the infrared spectra of water, H_2O, D_2O, and HDO, dissolved in six aromatic solvents (benzene, toluene, p-xylene, mesitylene, α-methylnaphthalene, and thiophene) reveals a water–solvent complexation, but not any water–water association. (France)

29287 SOME NEW PROPERTIES OF Mo(IV) AND Mo(V) HYDROXIDES. Souchay, P.; Cadiot, M.; Viossat, B. (Univ., Paris). Bull. Soc. Chim. Fr.; No. 3, 892-8(Mar 1970). (In French).

In the acidity range between 2N HCl and 8N NaOH, Mo(IV) may exist in the following forms (increasing alkalinity): $MoOCl^+$ → (pink chlorocomplex) → $MoO(OH)^+$ (brown basic ion) → $MoO(OH)_2$ (insoluble brown hydroxide) → $HMoO_2M$ (insoluble green-brown molybdite) → MoO_4^{--} (green-blue molybdite). Addition of bases to solutions of Mo(V) in the form of $Mo_4O_9^{++}$ causes precipitation of a hydroxide which, contrarily to that of Mo(IV), has cationic ex-

change properties. An excess of base transforms this hydroxide into Mo(VI) (MoO_4^{2-}) and Mo(IV) (molybdite $HMoO_3M$ or MoO_3^{2-}). (France)

29288 ANOMALOUS BEHAVIOUR OF ^{18}O-LABELLED COMPOUNDS. PART IV. VIBRATIONAL SPECTRA OF ISOTOPIC VANADATE IONS. Pinchas, S. (Weizmann Inst. of Science, Rehovoth, Israel); Shamir, J. Israel J. Chem.; 7: 805-11(1969).

The Raman spectra of crystalline hydrated normal and 80 atom % ^{18}O-labeled sodium orthovanadates were investigated, the bands observed thus being assigned to their respective original modes of vibration. The Raman bands of the aqueous solutions of these vanadates, containing mainly the respective HVO_4^{2-} or DVO_4^{2-} ions, were also studied and in most cases observed to rise in frequency as a result of the ^{18}O-labeling, as expected on the assumption that the hydrogen bonding between the solvating water molecules and the vanadate ions is weakened by ^{18}O-labeling the latter. (auth)

29289 KINETIC STUDIES ON THE REDOX REACTIONS OF URANIUM(III). Espenson, James H.; Wang, Robert T. (Ames Lab., Iowa). J. Chem. Soc., D; No. 4, 207-98(18 Feb 1970).

Studies on the rates of reduction of cobalt(III) and chromium(III) complexes by uranium(III) in perchloric acid solution have been carried out, with results indicating an inner-sphere mechanism in which hydroxide is a particularly favorable bridging ligand. (auth) (UK)

29290 PHOTOELECTRON SPECTROSCOPY OF HCl AND DCl USING MOLECULAR BEAMS. Weiss, M. J.; Lawrence, G. M.; Young, Robin A. (McDonnell Douglas Corp., Huntington Beach, Calif.). J. Chem. Phys.; 52: 2867-70(15 Mar 1970).

A focusing field electrostatic energy analyzer was used to examine photoelectrons from HCl and DCl using the 584 Å line of helium and the 736-744 Å doublet of neon. Ionization potentials for the $X\ ^2\Pi_i$ and $A\ ^2\Sigma^+$ states of HCl^+ and DCl^+ were determined and found to be essentially in agreement with values obtained by spectroscopic methods. Relative transition probabilities to the molecular-ion states were measured and are in agreement with calculated values. (auth)

29291 PREPARATION OF THE 1:2 URANYL NITRATE-METHYL DIPHENYL PHOSPHATE SOLID COMPLEX. Apelblat, A.; Levin, R. (Israel Atomic Energy Commission, Beer-Sheva). J. Chem. Soc., D; No. 9, 514(6 May 1970).

The anhydrous solid complex $UO_2(NO_3)\cdot$ (mdpp) (mdpp = methyl diphenyl phosphate) (mp 92°) is soluble in $CHCl_3$, dioxane, MeOH, C_6H_6, and Bu^iCOMe (i = iso) but almost insoluble in H_2O, dilute mineral acids, Pr^i_2O, and hydrocarbons. (auth)

29292 XENON HEXAFLUORIDE-URANIUM PENTAFLUORIDE COMPLEXES. Slivnik, J.; Frlec, B.; Zemva, B.; Bohinc, M. (Inst. Jozef Stefan, Ljubljana, Yugoslavia). J. Inorg. Nucl. Chem.; 32: 1397-1400(Apr 1970).

In the course of attempts to prepare pure XeF_4 by reduction of XeF_6 with UF_4, when a high surface area UF_4 was treated with excess XeF_6 at room temperature, the solid remaining after volatilization of UF_6, XeF_4, and XeF_6 had a composition corresponding to $UF_5\cdot 1.75\ XeF_6$. This solid decomposed to pale yellow $UF_5\cdot XeF_6$ on prolonged pumping at room temperature. The same compound was also obtained when UF_5 was treated with XeF_6 and the volatiles removed by extensive pumping at room temperature. $UF_5\cdot XeF_6$ was found to be soluble in anhydrous HF, to give bluish-green solutions from which it could be recrystallized unchanged. Magnetic susceptibility measurements were made, and found to obey the Curie-Weiss law over the temperature range 90 to 290°K. The effective magnetic moment was 1.57 BM, with the Weiss constant θ = 55°K. (UK)

29293 VARIATION OF THE MOLAR REFRACTION OF D_2O AND H_2O WITH THE TEMPERATURE AND THE WAVELENGTH. Mehu, Annick; Johannin-Gilles, Andree (Brest Univ., France). J. Chim. Phys.; 67: 19-24(Jan 1970). (In French).

The molar refractions of H_2O and D_2O were calculated for nine wavelengths between 6,438 and 4,047 Å and at temperatures from 15 to 90°C, every 5°C. The variation of the thermal coefficient of the molar refraction as a function of temperature for the wavelength 5,770 Å was investigated. The molar refraction shows a minimum at about 60°C for H_2O and about 50°C for D_2O. The molar refraction of D_2O is always lower than that of H_2O. (France)

29294 PREPARATION AND INFRARED (1700-1400 cm^{-1}) STUDY OF SOME ^{18}O-ENRICHED α-(DITHIOL-1,2-YLIDENE-3) ALKANONES. Festal, D.; Mollier, Y. (Faculte des Science, Caen, France). Tetrahedron Lett.; 15: 1259-62(1970). (In French).

Samples prepared by condensation or dehydrogenation with ^{18}O-labeled ketones showed in three instances a doubling of only one absorption band in comparison with the ^{16}O compound. Therefore, only this band can be assigned to a vibration involving the carbonyl group. The observed isotopic shifts are considerably less than those obtained by assuming this group to be independently vibrating. (UK)

29295 SPECTROSCOPIC STUDY OF THE CHEMILUMINESCENT REACTION O + CCO. Bayes, Kyle D. (Univ. of California, Los Angeles). J. Chem. Phys.; 52: 1093-7(1 Feb 1970).

Further spectroscopic studies of the chemiluminescence from oxygen atom-acetylene and oxygen atom-carbon suboxide flames are reported. The reaction, $^{18}O + CC^{16}O \rightarrow C^{18}O + C^{16}O$, results in the emission of Fourth Positive bands by both $C^{18}O$ and $C^{16}O$ with comparable intensities, suggesting that the intermediate OCCO exists for at least several vibrations. Some bands in the $d\ ^3\Delta \rightarrow X\ ^1\Sigma^+$ system are identified. Partially resolved rotational structure of the Fourth Positive bands show irregular intensities, which are interpreted as strong emission from perturbed rotational levels. It was concluded that the reaction forming excited CO in hydrocarbon flames populates the $A\ ^1\Pi$, $d\ ^3\Delta$, $e\ ^3\Sigma^-$, $I\ ^1\Sigma^-$, and $a'\ ^3\Sigma^+$ states of CO at comparable rates. Possible reactions of the metastable CO molecules are suggested. (auth)

29296 OXIDATION OF 4a, 4b-DIHYDROPHENANTHRENES. III. A THEORETICAL STUDY OF THE LARGE KINETIC ISOTOPE EFFECT OF DEUTERIUM IN THE INITIATION STEP OF THE THERMAL REACTION WITH OXYGEN. Warshel, A.; Bromberg, A. (Weizmann Inst. of Science, Rehovot, Israel). J. Chem. Phys.; 52: 1262-9(1 Feb 1970).

The large kinetic isotope effect of deuterium that occurs in the reaction of perdeuterio-4a, 4b-dihydrophenanthrene with O_2 was studied by a semiempirical calculation. The large effect was a consequence of two significant effects, the existence of quantum mechanical tunneling and the loss of zero-point energy. The theoretical study was mainly based on the construction of the potential surface by the method of bond eigenfunctions, and the treatment of the reaction as the solution of a 10-electron problem. The calculated tunneling effect, which was found by integration of all possible transmission probabilities through the potential barrier, resulted in factors of 11.8 at 242°K and 8.1 at 263°K. A conformational and normal mode analysis showed that the contribution of the zero-point energy effect amounts to a factor of 7.6 at 242°K and 6.4 at 263°K. (auth)

29297 THEORY OF THE COLLISION-INDUCED ROTATIONAL SPECTRUM OF TETRAHEDRAL MOLECULES. Ozier, Irving (North American Rockwell Corp., Thousand Oaks, Calif.); Fox, Kenneth. J. Chem. Phys.; 52: 1416-30(1 Feb 1970).

The general theory of induced absorption resulting from binary collisions was extended and applied to the pressure-induced far-infrared spectrum of a gas of tetrahedral molecules. The molecular octopole moment is related to the integrated intensity resulting from the modulation of the octopole-induced dipole moment by the rotational motion of the molecules. Translational effects are not considered. The intensity resulting from the overlap moment is estimated and found to be negligible. The quantum-mechanical analysis is presented using both unsymmetrized and symmetry-adapted wavefunctions. The results are compared, and the limitations of the unsymmetrized approach are discussed. The techniques developed in the symmetrized treatment are generally useful in integrated-intensity calculations for molecules with a high degree of symmetry and will be discussed in detail. The analysis is applied to recent room-temperature far-infrared data on CH_4, CD_4, and CF_4. The octopole moments deduced from the experimental spectra agree well with those obtained by other techniques. The general features of the spectrum are derived from the theory. The theoretical predictions concerning these features are found to agree well with experiment. The variation of the shape and integrated intensity of the theoretical spectrum with temperature over the range 110 to 500°K is also discussed. (auth)

29298 MATRIX-ISOLATION STUDY OF THE WATER DIMER IN SOLID NITROGEN. Tursi, Anthony J.; Nixon, Eugene R. (Univ. of Pennsylvania, Philadelphia). J. Chem. Phys.; 52: 1521-8(1 Feb 1970).

The infrared spectra of H_2O, D_2O, and HDO in nitrogen matrices at temperatures from 20 to 4°K reveal no evidence of rotation of the water molecules. Absorption features attributed to water dimers and the vibrational force constants calculated therefrom are indicative of an open structure with a single moderately weak hydrogen bond. The absence of certain HDO absorptions in the observed spectra can be interpreted as the manifestation of a stronger deuterium-vs-hydrogen bond. (auth)

29299 PHOTODISSOCIATION DYNAMICS. WAVELENGTH DEPENDENCE OF ENERGY PARTITIONING IN DEUTERIUM SULFIDE. Compton, L. E.; Martin, R. M. (Univ. of California, Santa Barbara). J. Chem. Phys.; 52: 1613-14(1 Feb 1970).

Kinetic determinations of hot D atom energies from D_2S photolysis at 1850 and 2288 Å are reported and compared with results from photolysis of H_2S. (M.C.G.)

29300 STUDIES ON URANYL COMPLEXES. V. HEATS AND ENTROPIES OF FORMATION OF URANYL CHELATES OF POLYAMINOCARBOXYLIC ACIDS. Frausto da Silva, J. J. R.; Simoes, M. Lourdes Sadler (Centro de Estudos de Quimica Nuclear, Lisbon). Rev. Port. Quim. (Lisbon); 11: 54-60(1969).

The heats and entropies of formation of the uranyl chelates of methyliminodiacetic acid, N-hydroxyethyliminodiacetic acid, ethylenediamine-NN'-diacetic acid, ethylenediaminetetraacetic acid, and ethyleneglycol-bis(aminoethyl ether) tetraacetic acid were determined by potentiometric titrations over a wide range of temperatures. Enthalpy effects are small and unfavorable; the reactions are determined by the entropy variations alone. The enthalpy and entropy variations on formation of the protonated species of the complexones are both favorable and the last ones may be correlated with the type of intramolecular hydrogen bridges that occur in these systems. (auth)

29301 CRYSTALLINE INSOLUBLE ACID SALTS OF TETRAVALENT METALS. IX. THORIUM ARSENATE, A NEW INORGANIC ION EXCHANGER SPECIFIC FOR LITHIUM. Alberti, G. (CNEN, Rome); Massucci, M. A. J. Inorg. Nucl. Chem.; 32: 1719-27(May 1970).

A new crystalline inorganic ion exchanger, with the formula $Th(HAsO_4)_2 \cdot H_2O$, was prepared by prolonged refluxing of a solution of thorium nitrate in arsenic acid. The hydrogen ion of this compound can be completely exchanged by Li^+ but not by larger ions such as Na^+ or K^+. This singular property, which is due to steric reasons, was utilized to carry out good separations of lithium from other alkali metal ions. Reversibility of ion exchange, and the chemical and thermal stabilities of this exchanger are also reported and discussed. (auth) (UK)

29302 EXCHANGE REACTION BETWEEN LIGHT ETHANE AND DEUTERIUM ON TUNGSTEN FILM. Kaneko, Yoshihisa; Oka, Shoichi (Utsunomiya Univ., Japan). Bull. Fac. Educ., Utsunomiya Univ.; No. 18-2, 54-7(Dec 1968).

Catalyzed exchange reaction between light ethane and deuterium on W film was investigated at the temperatures between 0 to 100°C with regards to adsorbed amounts of ethane and hydrogen and deuterium distribution in reacted ethane and hydrogen at several stage of exchange reaction. The results on the adsorption and deuterium distribution show that dissociative adsorption of ethane was considerably accelerated at the initial stage of reaction. The deuterium distribution in gaseous hydrogen was found random but not for ethane, which shows that the step of dissociative chemisorption of hydrogen is constantly in partial equilibrium but not the step of dissociative adsorption of ethane. (NSA of Japan)

29303 DEUTERON MAGNETIC RESONANCE OF THE SOLID PHASES OF DEUTERIUM SULFIDE. O'Reilly, D. E.; Eraker, J. H. (Argonne National Lab., Ill.). J. Chem. Phys.; 52: 2407-10(1 Mar 1970).

The deuteron magnetic resonance of D_2S was examined from 77°K to above the liquid-solid transition at 187°K. In solid III of polycrystalline D_2S, $e^2qQ/h = 142 \pm 9$ kHz and $\eta \approx 0.1$ independent of temperature. Solid II yields $e^2qQ/h = 88 \pm 4$kHz and $\eta = 0.30 \pm 0.01$. In solid I a very sharp deuteron resonance line is observed for which spin-lattice relaxation times (T_1) were determined. For solid III, the lattice is rigid and e^2qQ/h is 91% of the gas-phase value. Solid II is characterized by orientations of the S–D bonds by an approximately 90° flip motion with concomitant change of the direction of the bisectrix of the DSD angle and the direction of the D–D vector. This result is consistent with the previously observed dielectric constant and proton second moments in this phase. In solid I the averaging of the quadrupolar splitting is complete and the molecular reorientation is isotropic with a rotational correlation time (τ_2) of 4×10^{-13} sec just above the solid II-I phase transition (133°K). Previous proton resonance measurements are interpreted in terms of presently available data on the solid phases of hydrogen sulfide. (auth)

29304 SYNTHESIS OF NEW URANIUM COMPOUNDS. Hulliger, Fritz (to American Cyanamid Co.). U. S. Patent 3,506,410. 14 Apr 1970. Filed 9 Apr 1968.

A process is described for producing single crystals of a compound UXZ in which X is S, Se, or Te and Z is P, As, Sb, or Bi. The U–X–Z powder mixture is subjected to reaction with a transport gas, Cl, Br, or I, in vapor phase transport equipment at a temperature of 900 to 1300°C while another zone of the transport equipment is maintained at a temperature 50 to 100°C cooler until large plate-like crystals are produced. The compounds are ferromagnetic at low temperatures. (B.L.M.)

29305 FINAL RECTIFICATION OF HEAVY WATER. BATCH METHOD OF PRODUCTION. Gispert, M.; Rojas, J. L.; Echavarri, T.; Ortega, J. M. (Junta de Energia Nuclear, Madrid). An. Quim.; 64: 869-78(Sep-Oct 1968). (In Spanish).

The results obtained by using an alternate process in the rectification of the light–heavy water system are presented. A maximum yield was obtained for a heavy water concentration of about 50%, and the minimum yield was found at the ends of the x-y concentration diagram. A theoretical interpretation of this so-called heavy water batch production is presented. (auth)

29306 PRELIMINARY DATA ON THE PLUTONIUM(IV)–TARTARIC ACID SYSTEM. Ortega Abellan, J. (Junta de Energia Nuclear, Madrid). An. Quim.; 64: 899-901(Sep-Oct 1968). (In Spanish).

The system plutonium(IV)-tartaric acid was studied by liquid–liquid extraction using 30% TBP in kerosene as the organic phase. The results obtained led to the conclusion that plutonium(IV) in 0.8 to 2.0M nitric acid solutions forms a complex with tartrate ions (T^{2-}) of the constitution PuT^{2+}, the stability constant of which has a value of $3.2 \pm 0.3 \times 10^9$. (auth)

29307 PREPARATION OF ^{35}S-LABELED THIOACETAMIDE OF HIGH SPECIFIC ACTIVITY BY ISOTOPIC EXCHANGE WITH ELEMENTAL ^{35}S. Suarez Contreras, C. (Junta de Energia Nuclear, Madrid). An. Quim.; 64: 819-24(Sep-Oct 1968). (In Spanish).

Isotopic exchange in the system thioacetamide–$^{35}S_{(0)}$ was studied, and the exchange kinetics, rate constants at 80, 90, 110, and 130.5°C, as well as the activation energy were determined. In order to prepare high-specific-activity thioacetamide-^{35}S a study was made on the effects of sulfur concentration in the solution on exchange percentage. The preparation of thioacetamide-^{35}S according to this method offers several advantages (higher chemical and radiochemical yield, less preparation time, simplicity, etc.) in comparison with that previously described in the literature. (auth)

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Refer also to abstracts 29241 and 30386.

29308 (BMBW-FBK-70-4) ANNUAL REPORT, 1968. (Mainz Univ. (West Germany). Institut fuer Anorganische Chemie und Kernchemie). Feb 1970. 113p. (In German). Dep. CFSTI (U. S. Sales Only). ZAED DM 23.75.

The report is composed of the following parts: performance of a Triga reactor and Cockcroft–Walton accelerator; rapid chemical separations; decay properties of short-lived neutron-rich nuclei; mass and charge distribution in fission; detection of superheavy elements; activation analysis; and fallout studies. (auth)

29309 (UCLA-12-775) THE EFFECT OF CHLORIDE IONS ON THE γ-RADIATION INDUCED DESTRUCTION OF DNA, NUCLEOSIDES, AND NUCLEOTIDES IN AQUEOUS SOLUTION. Ward, J. F.; Kuo, I. (California Univ., Los Angeles, Lab. of Nuclear Medicine and Radiation Biology). [1969]. Contract AT(04-1)-Gen-12. 19p. Dep. CFSTI.

DNA in oxygenated aqueous solution is protected from the effects of ionizing radiation by chloride ions, as measured by chromophore destruction. The mechanism of this protection is probably a change in the mode of decay of the DNA-OH radicals and not a change in the primary attacking species. Chloride ions were found to have no effect on the γ-radioinduced decomposition of nucleosides and nucleotides in neutral solution. The chloride effects observed for these compounds in acid solution can be attributed to conversion of OH radicals to Cl_2^- ion radicals, and differences in the reaction of the latter species with solutes. There was no observable chloride effect on thymine or adenine compounds. The reaction of Cl_2^- with pyrimidine nucleosides and nucleotides resulted in destruction of the glycosidic bond and the release of undamaged base. This effect was not observed with the purine compounds or with the deoxyribose compounds. The radical which results from the reaction of Cl_2^- with guanine compounds reacts efficiently to reform the parent compound. (auth)

29310 (UCLA-12-776) ELECTRON SPIN RESONANCE STUDIES OF FREE RADICALS FORMED FROM OROTIC ACID. Huettermann, Juergen; Ward, John F.; Myers, Lawrence S. Jr. (California Univ., Los Angeles). [1970]. Contract AT(04-1)-Gen-12. 46p. Dep. CFSTI.

The paramagnetic species produced in orotic acid by γ irradia-

tion of single crystals and polycrystalline material as well as by reaction with hydroxyl free radicals in an aqueous system were studied by electron spin resonance (ESR) spectroscopy. Three species were observed in the spectra of the crystals, two of them free radicals associated with the orotic acid molecule and the third, cupric ions resulting from radiation effects on crystal impurities. The spectra of the latter were not investigated in full detail. One of the free radicals is formed by hydrogen addition to the 5-position of the pyrimidine ring, leaving an unpaired electron in a $2p_z$-orbital of carbon atom $C_{(6)}$. The couplings of the two β-hydrogen atoms at the 5-position are 22.8 and 34.2 Gauss, respectively. The principal values of the g-tensor are 2.0023, 2.0066, and 2.0031. The second radical results from a hydrogen added to an oxygen of the carboxyl group, giving rise to interaction of the radical electron on carbon $C_{(7)}$ with two hydroxyl protons. The hyperfine couplings of the latter are almost axially symmetrical with one $A_{||} \simeq 12$, $A_{\perp} \simeq 0$ Gauss, and the other $A_{||} \simeq 6$, $A_{\perp} \simeq 0$ Gauss. The g-tensor of this radical has principal values of 2.0022, 2.0090, and 2.0047. The spectra obtained from irradiated polycrystalline orotic acid can be explained on the basis of the same two radicals. Hydroxyl free radicals produced by the $Ti(III)-H_2O_2$ reaction add to the 5-position of orotic acid in acidic aqueous solution. The unpaired electron on carbon $C_{(6)}$ interacts with the β-proton on $C_{(5)}$ to produce a doublet of 11.8-Gauss spacing. Each doublet line is further split into three main lines with component spacing of 2.3 Gauss by interaction with the ^{14}N nucleus in 1-position. (auth)

29311 THERMOLUMINESCENCE AND GLOW PEAK SPECTRA OF LEAD FLUORIDE, BROMIDE, AND IODIDE. Bettinali, C.; Ferraresso, G.; Pacelli, E. (Univ., Rome). Z. Phys. Chem. (Frankfurt); 68: 167-74(Dec 1969).

Results obtained from the study of thermoluminescence and from the glow peak spectra of x-irradiated PbF_2, $PbBr_2$, and PbI_2 are reported. $PbBr_2$ gave a glow curve like that previously reported for $PbCl_2$ in the temperature range 80 to 350°K, but with different activation energies of the peaks. The spectra showed only the red component which is probably related to the $^3P_0 \rightarrow {}^1S_0$ transition. A working hypothesis suggests $^3P_1$ as an electron trap. Thermoluminescence spectra of PbF_2 and PbI_2 exhibited glow peaks strongly dependent on the radiation dose. Glow peak spectra differed from photoluminescence spectra. (J.G.B.)

29312 EPR SPECTRUM OF SILICA GEL IRRADIATED IN A REACTOR AT LOW TEMPERATURES. Berulava, B. G.; Nadirashvili, L. Sh.; Tsetskhladze, T. V. (Inst. of Physics, Tbilisi, USSR). Dokl. Akad. Nauk SSSR; 190: 369-71(11 Jan 1970). (In Russian).

The EPR spectrum of silica gel exposed to n,γ radiation doses ranging from 3 to 60 Mrad at 120°K was determined at liquid nitrogen temperature in vacuum or in contact with ethane immediately after irradiation and a few days later at room temperature. Similar measurements were made after keeping the sample at 77°K for one month. The EPR spectral lines were found to be broadened and asymmetric with respect to the sudden drop at the side of large fields. The signal obtained with the material irradiated in vacuum consisted of 3 components exhibiting a poorly resolved structure; increasing dose improved the resolution. In addition to the absorption lines, the doublet of atomic hydrogen adsorbed on the surface could be distinguished. The centers formed by the exposure interacted with the ethane gas and its radioactive destruction products resulting in the destruction of the paramagnetic centers. More defects were created in the silica gel irradiated in vacuum than in the material exposed in contact with ethane. It was concluded that the n,γ reactor irradiation creates paramagnetic centers which interact selectively with ethane and its radioactive decomposition products. Gamma radiation was responsible for most of the paramagnetic defects; the nonparamagnetic ones are attributed to the effects of the neutron flux. (TTT)

29313 INVESTIGATION OF γ-RADIOLYSIS OF SODIUM THIOSULFATE BY INFRARED SPECTROSCOPY AND MASS SPECTROMETRY METHODS. Natroshvili, G. R.; Nanobashvili, E. M. (Inst. of Inorganic Chemistry and Electro-Chemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 57: 589-92(Mar 1970). (In Russian).

Radiolysis of sodium thiosulfate by γ radiation was investigated. By means of mass spectrometry and infrared spectroscopy the main products of radiolysis were identified as sulfates, sulfites, elementary sulfur, and molecular hydrogen. The character of their accumulation and their radiation-chemical yields were established. On the basis of the present results the mechanism of sodium thiosulfate radiolysis is discussed. (auth)

29314 EINFUEHRUNG IN DIE KERNCHEMIE. (Introduction to Nuclear Chemistry). Lieser, Karl Heinrich. Kernchemie in Einzeldarstellungen. Band 1. Weinheim, Ger.; Verlag Chemie GmbH (1969). 730p.

Available at Cambridge University Press, New York.

A basic introduction to the total field of nuclear chemistry is presented. Topics covered include: periodic system of elements and nuclides, properties of atomic nuclei, isotope effects, isotope separation, radioactive decay, radioactive radiation, decay processes, nuclear reactions, chemical effects of nuclear reactions, radiation chemistry reactions, nuclear fuels and reactor chemistry, apparatus, production and chemistry of radionuclides, artificial elements, and uses. (M.C.G.)

29315 RADIATION-CHEMICAL OXIDATION MECHANISM OF HEXAVALENT INTO HEPTAVALENT NEPTUNIUM IN DILUTE BASIC AQUEOUS SOLUTIONS. Pikaev, A. K.; Shilov, V. P.; Krot, N. N.; Gel'man, A. D.; Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 190: 387-9(11 Jan 1970). (In Russian).

The oxidation mechanism involved in irradiation of aqueous solutions of Np(VI) saturated with nitrous oxide was examined, using a γ source at a dose rate of 1.75×10^{18} ev/ml · sec for the irradiation of the 3.6×10^{-3} M neptunium perchlorate solution in twice distilled water, diluting the solution further before exposure. The working specimens were prepared by adding a NaOH solution and bubbling nitrous oxide through it. The amount of Np(VII) formed was determined spectrophotometrically by absorption at the λ_{max} = 625 mμ. It was found that oxidation of the Np(VI) to Np(VII) takes place only in solutions saturated with N_2O. Addition of 0.1 mol/l of NO_3^- ions completely suppresses the oxidation. The Np(VII) yield was practically independent of the Np(VI) concentration within the 2×10^{-4} to 5×10^{-4} M range. On the basis of the data an equation was derived to describe the oxidation mechanism involved, taking into account the competing processes. (TTT)

29316 FRACTIONATION OF BLOCK COPOLYMERS OF POLY(ISOBUTYLENE)–POLY(STYRENE) PREPARED BY A RADIOCHEMICAL METHOD. SPECIAL POLYDISPERSITY PROPERTIES RELATED TO CHEMICAL COMPOSITION. Danon, J.; Jozefowicz, J. (Faculte des Sciences, Orsay, France). Eur. Polym. J.; 6: 199-204(1970). (In French).

The data obtained elsewhere on molecular weight fractionation of two poly(isobutylene)–poly(styrene) radioinduced block-copolymers are examined. It was concluded that the two copolymers show the same peculiar chemical polydispersity: short chains are chemically polydisperse and have a variable styrene content while long chains are only slightly chemically polydisperse and have a constant styrene content. This observation, as well as the quantitative differences between the two copolymers, agrees very well with theoretical expectations. (auth)

29317 NEW TYPE OF RADICAL IN IRRADIATED SINGLE CRYSTALS OF CARBOXYLIC ACIDS. Iwasaki, Machio; Eda, Bunzo; Toriyama, Kazumi (Government Industrial Research Inst., Nagoya, Japan). J. Amer. Chem. Soc.; 92: 3211-12 (20 May 1970).

ESR spectra of a single crystal of maleic acid irradiated at 77°K show that a new type of radical with a large g anisotropy and a small hyperfine structure is one of the products. It is very unstable and disappears by subsequent exposure to a tungsten light or by warming slightly from 77°K. (M.C.G.)

29318 A COMPARATIVE STUDY OF THE GAS-PHASE RADIATION CHEMISTRY OF PHOSPHINE AND AMMONIA. Buchanan, James W.; Hanrahan, Robert J. (Univ. of Florida, Gainesville). Contract AT-(40-1)-3106. Radiat. Res.; 42: 244-54(May 1970). (ORO-3106-26).

Comparison studies of the decomposition in the gas phase of pure phosphine and pure ammonia by ^{60}Co gamma rays show that both compounds are broken down to their elemental constituents. Results of mass balance experiments with pure phosphine indicate that the overall radiolysis reaction is $PH_3 \rightarrow P_{red} + \frac{3}{2} H_2$. G for hydrogen production is 11.3 (molecules formed per 100 eV absorbed energy), over the dose range 0.4×20^{20} eV to 5×10^{20} eV, beyond which the G value decreases. From 50 Torr to 1 atm the product yield is proportional to phosphine pressure, extrapolating to zero yield at zero pressure. Yields of nitrogen and hydrogen from the radiolysis of gaseous ammonia are proportional to dose from 1×20^{20} eV to 5×10^{20} eV, with G values of 1.5 and 4.5, respectively. The total product yields extrapolate to zero yield at zero dose. The absorbed dose rates were determined by measuring the hydrogen yield from irradiated ethylene, assuming a G value of 1.2 and electron stopping powers (relative to ethylene) of 1.041 for PH_3 and 0.661 for NH_3. (auth)

29319 RADIATION-INDUCED RADICALS IN THYMINE: ESR STUDIES OF SINGLE CRYSTALS. Henriksen, Thormod;

Snipes, Wallace (Univ. of California, Berkeley). Contracts W-7405-eng-48; AT(30-1)-3799. Radiat. Res.; 42: 255-69 (May 1970).

The radicals induced in single crystals of thymine monohydrate by ionizing radiation were studied by ESR. Both at 77°K and at room temperature three different radicals are formed. The spectral changes observed at different temperatures are due to variations in the relative yields of these three radicals. In addition to the previously known 5-thymyl (5,6-dihydrothymin-5-yl) radical, two other radicals were identified. The hyperfine splitting tensors and the directions of the principal axes show that for both radicals the unpaired spin density is mainly in a p_π orbital on C_6. One radical has hyperfine coupling to one α and one β proton; the other radical has coupling to one α proton only. The radicals are the 6-thymyl (5,6-dihydrothymin-6-yl) radical formed when a hydrogen atom is added to C_5, and a radical in which a hydrogen atom is added to the oxygen atom bonded to C_4. The latter radical is presumably formed by electron capture with subsequent proton tunneling in the hydrogen bond to the water molecule. (auth)

29320 RADIATION GRAFT COPOLYMERIZATION OF ACRYLIC ACID AND STYRENE FROM THE VAPOR MIXTURE ON POLYPROPYLENE FIBERS. Golubev, V. N.; Korshak, V. V.; Tsetlin, B. L. (Inst. of Organoelementary Compounds, Moscow). Dokl. Akad. Nauk SSSR; 190: 846-8(1 Feb 1970). (In Russian).

Previous findings revealed that the rate of the radioinduced graft-copolymerization process of acrylic acid and styrene is controlled by the monomer concentration in the adsorbed phase and not by the concentration in the vapor phase itself. Therefore, the sorption of the monomers on the fibers and the correlation between the composition between the vapor phase and the adsorbed layer were studied, and it was found that the adsorption process possesses an additive character. It was also observed that even a slight styrene content in the adsorbed layer sharply reduces the reaction rate. The results indicated that the radiation graft copolymerization from the vapor phase on synthetic fibers follows the free-polymer mechanism. Earlier studies of the radiation graft copolymerization from the liquid phase yielded erroneous results because the composition of the liquid mixture and not that of the layer on the supporting fibers was taken into consideration. (TTT)

29321 THE DIFFERENTIAL CALORIMETRIC STUDY OF THE REACTIVITY OF UNSTABLE COMPOUNDS. Koch, Erhard (Max-Planck-Institut fuer Kohlenforschung, Muelheim/Ruhr, Ger.). Angew. Chem. Int. Ed. Engl.; 9: 288-300(Apr 1970).

The detection of unstable intermediates in chemical, photochemical, and radiochemical reactions can be greatly facilitated by the use of thermoanalytical methods. Special advantages are offered by differential thermal analysis (DTA), since it permits fast, easy investigation, from about –150°C upward in some cases, over a wide temperature range. In this way processes that under normal conditions follow one another with immeasurable rapidity can be separated on the basis of their different temperature dependences. The great sensitivity of the method also allows the use of very dilute solutions, so that the studies can be confined to unimolecular processes. The value of the method for the determination of energetic and kinetic data is illustrated by its application to the photochemically obtainable, unstable, ozonide-like epidioxydihydrofurans. (auth)

29322 ELECTRON SPIN RESONANCE STUDY ON THE MECHANISM OF ELECTRONIC REDUCTION OF ANTHRAQUINONE DERIVATIVES IN DIMETHYLFORMAMIDE. Yasukouchi, Kazuo; Yamaguchi, Hiroko; Nagayama, Sanpei (Kumamoto Univ., Japan). Nippon Kagaku Zasshi; 91: 213-19(Mar 1970). (In Japanese).

In a nonaqueous solvent, DMF, anthraquinone(AQ) derivatives undergo two one-electron polarographic reductions, and are reduced in two stages by ^{60}Co γ irradiation or uv irradiation. In order to confirm the anion–radicals which are intermediates in the reduction process, effects of the kinds and positions of substituents and of water content in DMF on the fine structure of radicals were studied by ESR. Electron–densities of AQ derivatives and spin–densities of their anion–radicals were calculated by the molecular orbital method. An effort was made to establish a relationship between half-wave potential $E_{\frac{1}{2}}$ and energies of the lowest vacant orbitals. ESR spectra were reported at 3370 ± 5 to 10 gauss for twenty-three AQ derivatives except 2–OH · AQ and 1,3–$(OH)_2$ · AQ. The relationship between spin–density and splitting constant was classified into three different groups by the kinds of E–effect of substituents. On the basis of the electron–densities calculated, it was confirmed that the position of reduction was 9 or 10. Except 1,8– and 1,3–$(OH)_2$ · AQ, the position of the first reduction was in satisfactory agreement with the position judged from the value of $E_{\frac{1}{2}}$. It was found that the relation between $E_{\frac{1}{2}}$ and energies of the lowest vacant orbitals was affected by kinds and properties of substituents rather than the AQ ring itself. (auth)

29323 RADIOLYSIS OF THYMINE IN AQUEOUS AERATED SOLUTION. KINETIC STUDIES FOR γ RAY FLUXES OF 200 RADS. Teoule, Robert; Cadet, Jean. (Commissariat a l'Energie Atomique, Grenoble, France). Bull. Soc. Chim. Fr.; No. 3, 927-32(Mar 1970). (In French).

Thymine was irradiated with ^{60}Co γ rays in aqueous aerated solution. Some 20 products were isolated by paper and thin-layer chromatography after irradiation at high dose levels. The main products were measured for three ^{14}C-thymine concentrations ($2 \cdot 10^{-3}$ M, $2 \cdot 10^{-4}$ M, $2 \cdot 10^{-5}$ M) and for γ flux from 200 rads to 10^6 rads. At very low irradiation levels only five products were detected and produced in appreciable amounts. (France)

29324 ELECTRONIC STRUCTURES AND ELECTRONIC ABSORPTION SPECTRA OF CYCLOHEXADIENYL AND RELATED RADICALS PRODUCED BY γ-IRRADIATION. Shida, Tadamasa; Hanazaki, Ichiro. (Inst. of Physical and Chemical Research, Saitama, Japan). Bull. Chem. Soc. Jap.; 43: 646-51(Mar 1970).

The electronic absorption spectrum for the cyclohexadienyl radical produced upon γ irradiation of pure benzene and benzene–alcohol solutions at 77°K was investigated. In addition to the absorption band at 3.9 eV, a weak band with a prominent vibrational structure was observed at 2.2 eV. An SCF–CI molecular orbital calculation was carried out for the radical taking into account explicitly the hyperconjugation effect of methylene group. The theory predicts the two observed bands with satisfactory accuracy. The calculated spin densities are also in good agreement with the existing ESR data of the radical. Vibrational analysis was carried out for the band system at about 2 eV as well as for the corresponding bands of isotopically mixed radicals, C_6H_6D, C_6D_6H, and C_6D_7. Parallel calculations for hydronaphthyl radicals are also in harmony with the available experimental data of optical and ESR measurements. (auth)

29325 OPTICAL AND ESR STUDIES ON TRIPHENYLIMIDAZOLYL RADICALS PRODUCED BY PHOTOLYSIS AND RADIOLYSIS AT LOW TEMPERATURE. Shida, Tadamasa (Inst. of Physical and Chemical Research, Saitama, Japan); Maeda, Koko; Hayashi, Taro. Bull. Chem. Soc. Jap.; 43: 652-7(Mar 1970).

The characteristic temperature-dependent behavior exhibited by the solution of photochromic dimer of triphenylimidazolyl (photo-dimer) was reinvestigated by means of optical and ESR spectroscopy. Two conformations for triphenylimidazolyl radical are assumed, and the spectral change at low temperatures is elucidated in terms of a conformational isomerization of the radical and dimerization of the radical to a colorless dimer. Photo-dimer in γ-irradiated glassy solutions undergoes a dissociative electron attachment to produce triphenylimidazolyl radical and its anion. (auth)

29326 ESR SPECTRA OF γ-IRRADIATED LINEAR ALIPHATIC POLYESTERS. Nozawa, Yasuo (Science Univ. of Tokyo). Bull. Chem. Soc Jap.; 43: 657-62(Mar 1970).

The ESR spectra of γ-irradiated linear aliphatic polyesters (2.2, 2.4, 2.6, 2.7, 2.8, and 6.8 polymer) were measured at various temperatures ranging from 77°K to room temperature. Two types of spectra are obtained in these polyesters except for the 2.2 polymer. The first, the six-line spectrum obtained at low temperatures, was relatively short-lived and increased in signal intensity with increasing methylene groups of these polyesters. The well-resolved, second, five-line spectrum was stable even at room temperature in comparison with the former. The possible structures of two radicals are discussed. (auth)

29327 THERMAL ANNEALING BEHAVIOR OF RECOIL MANGANESE ATOMS PRODUCED IN ALKALI METAL PERMANGANATES BY (n,2n) AND (n,γ) REACTIONS. Shiokawa, Takanobu; Sasaki, Teikichi (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap.; 43: 801-4(Mar 1970).

The thermal annealing behavior of recoil manganese atoms produced in alkali metal permanganates by ^{55}Mn(n,2n)^{54}Mn and ^{55}Mn(n,γ)^{56}Mn reactions was studied. In the case of potassium permanganate, the thermal annealing of ^{54}Mn proceeded faster than that of ^{56}Mn. The retention of ^{54}Mn in the annealing curve decreased after an initial increase when it was treated at 180°C, whereas this anomaly was not observed in the case of ^{56}Mn. These differences in the annealing behavior of the two nuclides were ascribed to the effects of background gamma radiation during the neutron irradiation and also to the differences in recoil energies. An effect of the counterpart cations of permanganate was also observed

in the thermal annealing behavior, and was interpreted in terms of the ionization potential of alkali metal. (auth)

29328 COS AS AN ELECTRON SCAVENGER IN LIQUID-PHASE RADIOLYSIS. Hirokami, Shun-ichi; Shishido, Seishi; Sato, Shin (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 43: 973(Mar 1970).

When COS was used as the solute in the γ radiolysis of benzene, CO was produced. The competition between COS and N_2O for electrons in the radiolysis of benzene was also studied. (J.G.B.)

29329 STRUCTURAL CHANGES ON IRRADIATION GRAFTING AND SUBSEQUENT HYDROLYSIS OF SOME SYNTHETIC FIBERS AS REVEALED BY INFRARED SPECTROSCOPIC TECHNIQUE. Potnis, S. P. (Univ. of Bombay); Shetty, S. M.; Prakash, Jai. Text. Res. J.; 40: 389-92(Apr 1970).

Polyester (Terene), polyamide (Nylon 6), and polypropene filament yarns were γ-radioinduced grafted with vinyl acetate, methyl methacrylate, and acrylonitrile. The grafted yarns were hydrolyzed with 0.1% methanolic KOH. The refluxing time and alkali concentration were chosen so that the mechanical properties were not appreciably affected by the hydrolysis. The ir spectra of the ungrafted, grafted, and hydrolyzed yarns were studied by means of KBr pellets. The changes in the location and intensity of the principal peaks observed are tabulated. (J.G.B.)

29330 EFFECTS OF IONIZING RADIATION ON THE THERMAL PROPERTIES OF LINEAR HIGH POLYMERS. PART 5. ETHYLENE/ISOTACTIC PROPYLENE BLOCK COPOLYMER. Gee, D. R.; Mella, T. P. (Univ. of Salford, Eng.). Makromol. Chem.; 133: 273-7(1970).

The results of heat capacity measurements (over the temperature range 200 to 500°K) on an ethylene–isotactic propylene block copolymer (containing 12 mole % ethylene), which were subjected to different doses of gamma radiation (0 to 1,000 Mrads) at 298°K, are described. After irradiation a single endotherm replaces the two observed with the unirradiated sample. The dependence of both the enthalpy and entropy of fusion on radiation dose is similar to that observed previously with isotactic polypropylene. (auth)

29331 ENERGY MIGRATION IN THE RADIOLYSIS OF SOLIDS. Dharmawardena, K. G.; Maddock, A. G. (Cambridge Univ., Eng.). J. Chem. Soc., D; No. 9, 549(6 May 1970).

Energy migration, leading to radiolytic decomposition, can be investigated by measuring the number of molecules of a solute decomposed per unit energy deposited in the crystals, as a function of dilution, using isomorphously incorporated mixed crystals. (auth) (UK)

29332 γ-RAY AND ULTRAVIOLET GRAFT COPOLYMERIZATION OF MALEIMIDE BY VAPOR-PHASE METHOD. Hayakawa, Kiyoshi; Yamakita, Hiromi; Kawase, Kaoru (Government Industrial Research Inst., Nagoya, Japan). J. Polym. Sci., Part A-1; 8: 1227-37(May 1970).

Graft copolymerization of maleimide on ethyl cellulose and polyethylene films by using its sublimation vapor was carried out under γ or ultraviolet radiation. When polyethylene film was used as a backbone polymer the grafting reaction proceeded without a perceptible sorption of monomer, while a considerable amount of monomer was captured into ethyl cellulose film and grafting of the sorbed monomer was observed. The monomer seemed to be monomolecularly dispersed in this film. The presence of air retarded the reaction. The grafted films were characterized by strong infrared absorption bands due to polymaleimide branching. The fractions assigned to the graft copolymer were isolated from the grafted films by selective elution. The grafted branches were supposed to be very short, judging from the polymaleimide contents of those fractions. (auth)

29333 EFFECTS OF THE PRETREATMENT ON THE ANNEALING OF $KSb(OH)_6$ IRRADIATED BY NEUTRONS. Facetti, J. F. (Univ., Asuncion, Paraguay). Rev. Soc. Cient. Paraguay; 10: No. 1-2, 15-19(1969). (In Spanish).

When $KSb(OH)_6$ samples previously treated with ^{60}Co γ rays or crushed are irradiated with neutrons, the yield of Sb^V and the annealing mechanism are apparently modified by the pretreatment. In addition it is shown that metastable species of Sb^{IV} are formed under irradiation. (auth)

29334 EFFECT OF OLEFINS ON THE RADIOLYSIS OF LIQUID CYCLOHEXANE. PART 3. van Ingen, J. W. F.; Cramer, W. A. (Interuniversitair Reactor Instituut, Delft, Netherlands). Trans. Faraday Soc.; 66: 857-60(Apr 1970).

Effects of various olefins, notably propylene, 1-butene, 2-pentene, 2-methyl-2-butene and 2,3-dimethyl-2-butene, on the hydrogen yield from the γ-radiolysis of pure cyclohexane were investigated. In all cases an initial sharp reduction in $G(H_2)$ was followed by a more gradual decrease until a nearly constant residual hydrogen yield is obtained. Observed differences in these residual yields are consistent with a charge-transfer mechanism. It is suggested that the probability of charge transfer from cyclohexane to olefins increases with increasing differences in ionization potentials. H_2-transfer from cyclohexane positive ions to olefins may also occur. The probability of this reaction increases with decreasing difference in ionization potentials of solvent and solute. (auth) (UK)

29335 FORMATION AND TRANSFORMATION OF RADICALS IN MESO-INOSITOL UNDER THE EFFECT OF γ-RADIATION. Nikitin, I. V.; Sharpatyi, V. A.; Kudryashov, L. I.; Kochetkov, N. K.; Emanuel, N. M. (Inst. of Organic Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 190: 635-8(21 Jan 1970). (In Russian).

The nature and properties of radicals formed during γ irradiation of meso-inositol were studied. The compound can be used as a model for studying the mechanism of radiolysis of polyhydroxyl-containing compounds. The radicals were recorded at 77°K by EPR after irradiation of dry polycrystalline specimens, crystal hydrates, and frozen 0.5M aqueous solutions of meso-inositol. Two groups of radicals were recorded in polycrystalline specimens. One group was composed of OH and R radicals; the other group contained RO radicals. It was noticed that even a small amount of water inhibited certain radiolysis series, especially, in the formation of the first group of radicals (the break up of the C–O bond). (R.V.J.)

29336 RADIOLYTIC FORMATION OF NO FROM SODIUM NITROPRUSSIATE. Cottin, Maurice; Danon, Jacques (Institut du Radium, Paris, Univ., Paris). Compt. Rend., Ser. C; 270: 1069-70(23 Mar 1970). (In French).

The formation of the free radical NO from solid sodium nitroprussiate (indexed as sodium pentacyanonitrosylferrate) irradiated at 77°K by gamma radiation was observed by mass spectrometry. (France)

29337 RADIATION-INDUCED COPOLYMERIZATION OF MONOMERS TO FIBRES. Dilli, S.; Garrett, J. L.; Martin, E. C.; Phuoc, D. (New South Wales Univ., Kensington). Proc. Roy. Aust. Chem. Inst.; 36: 311-14(Oct 1969).

Several solvents influencing γ or electron radioinduced grafting of styrene monomers to the cellulose trunk polymer are compared. A mechanistic discussion shows the importance of radio-induced trapped radicals in grafting reactions. The molecular weights of the grafted cellulose chains are appreciably higher ($\approx 10^6$) than those found in materials prepared by chemically initiated procedures. (Australia)

29338 FURTHER STUDIES OF REACTIONS OF HOT HYDROGEN WITH HYDROCARBONS. Baker, R. T. K.; Silbert, M.; Wolfgang, R. (Yale Univ., New Haven. Univ. of Colorado, Boulder). J. Chem. Phys.; 52: 1120-32(1 Feb 1970).

A further quantitative examination of the reactions of recoil tritium with hydrocarbons was made. Reaction probabilities for various types of processes were determined as a function of neon moderation. Data were analyzed using the kinetic theory of hot reactions. This theory was extended to indicate the relative mean energies and overlap of the excitation functions for the several possible reactions. Reactivity integrals I and energy loss parameters α increased with increasing complexity of the reactant molecule. This appeared to be associated with the greater ability of larger molecules to absorb the excess energy of hot tritium atoms. Abstraction appeared to occur at higher average energies than displacement. Since abstraction is known to be dominant at lower energies, this means that it can also occur efficiently at higher energies than displacement. These findings accord with a previously postulated stripping mechanism for abstraction and with the observed effect of bond energy on this process. Displacement reaction was restricted to a relatively narrow energy range in methane but can extend to higher energies in higher hydrocarbons. (auth)

29339 ESR OF ^{17}O-LABELED PO_3^{2-} ION TRAPPED IN A SINGLE CRYSTAL OF $Na_2DPO_3.5D_2O$. Schlick, S. (Technion–Israel Inst. of Tech., Haifa); Silver, Brian L.; Luz, Z. J. Chem. Phys.; 52: 1232-7(1 Feb 1970).

The ESR spectrum of an x-irradiated ^{17}O-enriched $Na_2DP^{17}O_3 \cdot 5D_2O$ single crystal is reported. The results show unambiguously that the radical formed is PO_3^{2-}. The values and directions of the principal components of the ^{17}O and ^{31}P hyperfine tensors were determined and were used to derive values for the atomic-orbital coefficients in the $6a_1$ molecular orbital containing the odd electron. The relative orientation of the two magnetically inequivalent PO_3^{2-} radicals in the unit cell in deuterated crystals was found to differ markedly from that in the isotopically normal crystal. (auth)

29340 ELECTRON TRAPPING AND HYDROGEN-ATOM REACTIONS IN IRRADIATED POLYETHYLENE. Partridge, Roger H. (Royal Military Coll. of Science, Shrivenham, Eng.). J. Chem. Phys.; 52: 1277-85(1 Feb 1970).

The absorption spectrum of electrons trapped in polyethylene during irradiation at low temperature was studied and an approximate G value for this of ~0.8 at low doses was deduced. The spectrum stretches from the vacuum ultraviolet to the infrared (thus differing entirely from that in short-chain branched alkanes) and changes somewhat with increasing radiation dose. Another absorption spectrum is found, which bleaches thermally but not optically, that is probably due to alkyl radicals. Thermal H atoms were studied at low temperature by adding benzene to the polyethylene and observing the ultraviolet absorption spectrum of the resulting cyclohexadienyl radicals. The G value for thermal H atom production was found to be ~1.8, similar to the value in short-chain alkanes at room temperature, and the atoms apparently migrated considerable distances even at −170°C. Addition also of olefin with the benzene showed that olefin double bonds react ~600 times more efficiently with thermal H atoms than do methylene groups, but despite this H atom capture is not an important mechanism for the destruction of these double bonds by radiation. (auth)

29341 PREPARATION OF ^{51}Cr OF HIGH SPECIFIC ACTIVITY BY NEUTRON IRRADIATION OF POTASSIUM CHROMATE. INFLUENCE OF FAST NEUTRONS. Jimeno de Osso, F. (Junta de Energia Nuclear, Madrid). An. Quim.; 64: 1045-52(Dec 1968). (In Spanish).

In order to know quantitatively the effect of fast neutrons on the specific activity of chromium-51 obtained by a Szilard–Chalmers process on K_2CrO_4, systematic irradiations of this material were carried out in different locations in the thermal column and other available facilities of the JEN-1 reactor. As a result, the equivalent thermal and fast neutron fluxes were measured in all the irradiation positions used, and it was found that specific activities as high as 173 mCi/mg of Cr can be achieved in the thermal column. (auth)

29342 ESR STUDY OF PARAMAGNETIC SPECIES PRODUCED BY γ-IRRADIATION OF HYDROCARBONS IN CLATHRATES AT 295°K AND AT 77°K. Nowak, Zofia; Stachowicz, Waclaw (Inst. of Nuclear Research, Warsaw). Nukleonika; 14: 1114-21(1969).

The clathrates (inclusion compounds) of n-octane and n-octene with urea were irradiated in a ^{60}Co source at ambient temperature as well as at 77°K and subsequently examined by ESR technique. The spectra of randomly oriented clathrate crystal needles were confronted with those of parallel settled. The recorded ESR spectra were compared with those of pure frozen hydrocarbons irradiated and measured at 77°K. In a similar way the clathrates of isooctane with thiourea were examined. The single central line observed in the spectra of urea clathrates was attributed to the trapped electrons. (auth)

29343 GAMMA-RADIATION EFFECTS ON POLYMERS. I. GLYCOL/TETRACHLORO-σ-PHTHALATE POLYESTERS IN AIR AND IN NITROGEN AND UNDER VACUUM. Ghanem, N. A. (National Research Centre, Cairo); El-Azmirly, M. A.; Aly, M. I. Eur. Polym. J.; 6: 443-52(1970).

Saturated polyesters containing tetrachloro-σ-phthalate units were prepared, purified, and then subjected to γ radiation in a ^{60}Co cell for various doses up to 236·448 Mrad, in air, in nitrogen, and under vacuum (10^{-4}–10^{-6} mmHg). Considerable dehydrohalogenation together with systematic slight increase in acid value take place upon irradiation in nitrogen or under vacuum indicating slight degradation of the polyester chains. In addition, thermogravimetric analyses of the polymers before and after irradiation showed that some crosslinking takes place on irradiation in vacuo. (auth)

29344 METHYLENE FORMATION IN THE RADIOLYSIS OF METHANE: THE USE OF TRANS-BUTENE-2 AS A DETECTOR. Hummel, R. W. (United Kingdom Atomic Energy Authority, Wantage, Eng.). Int. J. Radiat. Phys. Chem.; 2: 31-7(Apr 1970).

The γ irradiation of mixtures of trans-butene-2 with rare gases and with CH_4 gives rise to the formation of a number of unsaturated compounds containing five carbon atoms and, in the CH_4 system, to significant amounts of cis- and trans-dimethylcyclopropane. From the distribution of products and the effects of radical, proton, and electron scavengers it was found that the methylene radical, CH_2, is produced by the radiolysis of CH_4, but not from C_4H_8. About half the CH_2 has an ionic precursor; CH_5^+ is suggested. No conclusion could be reached as to the initial spin state of the CH_2. (auth) (UK)

29345 THE RADIOLYSIS OF ALCOHOLS AT LOW TEMPERATURES. II. THE PRECURSORS OF HYDROGEN IN GLASSY ALCOHOLS UP TO n-HEXANOL INCLUDING ALLYL ALCOHOL. THE HYDROGEN FORMATION IN IRRADIATED GLASSY ALCOHOLS AT 77 K. Teply, J.; Janovsky, I.; Habersbergerova, A.; Karasova, L. (Nuclear Research Inst., Czechoslovak Academy of Sciences, Rez, Czech.). Int. J. Radiat. Phys. Chem.; 2: 21-30 (Apr 1970).

The mechanism of hydrogen formation in the γ radiolysis of glassy ethanol, n-propanol, isopropanol, n-butanol, n-pentanol, and n-hexanol is analogous to the mechanism found in methanol. The precursors of hydrogen are trapped electrons and hydrogen atoms, and there is also unscavengeable hydrogen. The yields of trapped electrons are approximately equal ($G \approx 2$) as are those of the unscavengeable hydrogen ($G \approx 1.3$), while the yields of hydrogen atoms show greater fluctuations about the value ≈1. The difference in the hydrogen yields after optical and thermal bleaching in ethanol and propanol are similar to that in methanol; on optical bleaching probably a photochemical decay of the trapped electron occurs while on thermal bleaching a reaction of the migrating electron with the protonated molecules of the alcohols takes place. In the first case, the hydrogen atom formed abstracts another hydrogen from a molecule of alcohol, in the second one it abstracts to a lesser extent or not at all. The difference between the hydrogen yield on optical and thermal bleaching gradually disappears with increasing chain length of the alcohol. Allyl alcohol behaves quite differently: the electrons are not trapped and they take part in the formation of hydrogen only to a small extent ($G \approx 0.7$); the yield of the unscavengeable hydrogen is ≈0.4. (auth) (UK)

29346 EXCITATION ENERGY TRANSFER IN ALKANES. III. RADIATION CHEMISTRY OF ALKANE POLYMERS. Partridge, Roger H. (Royal Military Coll. of Science, Shrivenham, Eng.). J. Chem. Phys.; 52: 2501-10(1 Mar 1970).

The predictions made by exciton theory on high efficiency energy transfer in alkanes, particularly alkane polymers, are compared with available experimental data, and as far as can be ascertained at present the two are almost completely consistent with one another. (auth)

29347 EXCITATION ENERGY TRANSFER IN ALKANES. II. EXPERIMENTAL DEMONSTRATION. Partridge, Roger H. (Royal Military Coll. of Science, Shrivenham, Eng.). J. Chem. Phys.; 52: 2491-2500(1 Mar 1970).

A very efficient energy-transfer process is reported here that occurs in alkane molecules during irradiation with an efficiency which is strongly dependent on molecular chain length. The energy transfer is detected by addition of small amounts of suitable additives that ionize or dissociate into fragments, which can be detected by visible and uv absorption measurements. Such energy transfer has hitherto usually been explained on a positive charge-transfer model, but the evidence here strongly suggests that excitation energy transfer is in fact the dominant mechanism and that some reassessment of the other model may be needed. Energy transfer occurs predominantly along the molecular chains, over distances at least ~1500 Å in long chain alkanes. (auth)

29348 EXCITATION ENERGY TRANSFER IN ALKANES. I. EXCITON MODEL. Partridge, Roger H. (Royal Military Coll. of Science, Shrivenham, Eng.). J. Chem. Phys.; 52: 2485-90 (1 Mar 1970).

The molecular exciton theory of sigma bonds, which was set up previously to explain the vacuum-ultraviolet absorption spectra of alkanes, is applied here to the primary radiation chemical reactions of linear and branched alkane polymers. From this a number of theoretical predictions are made, the most important being that very efficient excitation energy transfer will occur along the CC bonds of the polymer main chains without causing main chain scission but that excitation energy in CH bonds will be localized in pairs of these bonds and give rise here to a high rate of scission. These predictions are examined in detail using experimental data. (auth)

29349 γ RADIOLYSIS OF LIQUIDS AT HIGH PRESSURES. VIII. PRIMARY YIELDS AT 8.7 KBAR AND REACTIONS OF THE HYDRATED ELECTRON WITH H_2O AND H_3O^+. Hentz, Robert R.; Knight, Ronald J. (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 52: 2456-9(1 Mar 1970).

Pressure invariance of the primary yields of water radiolysis (previously established for pressures up to 6.4 kbar) was shown to extend to 8.7 kbar in γ radiolysis of both neutral and 0.8N H_2SO_4 solutions. $G(H_2)$ was measured in γ radiolysis of the following deaerated solutions at 25° and pressures in the range 0 to 8.85 kbar: (a) 3×10^{-5}M $NaNO_3$ and 0.05M glucose (slightly alkaline); (b) 10^{-3}M $NaNO_3$, 2.3×10^{-4}M $HClO_4$, and 0.05M glucose. In solution (a) $G(H_2)$ is determined by a competition for e^-_{aq} between the diffusion-controlled reaction, $e^-_{aq} + NO_3^- \rightarrow$ no H or H_2, and

the reaction $e^-_{aq} + H_2O \rightarrow H + OH^-$. In solution (b) the competition is between $e^-_{aq} + NO_3^- \rightarrow$ no H or H_2 and $e^-_{aq} + H_3O^+ \rightarrow H + H_2O$. All H are converted to H_2 by reaction with glucose. With the assumption that pressure dependence of k_3 is determined approximately by that of water viscosity, kinetic analysis of the results gives $\Delta V_1^\ddagger = -14.3$ ml mole^{-1} and $\Delta V_2^\ddagger \approx 0$ ml mole^{-1}. From the value of $\Delta V_2^\ddagger$, the absolute partial modal volume of e^-_{aq} (based on a value of -5.4 ml mole^{-1} for H^+) is estimated to be in the range 0 to 11.3 ml mole^{-1}. With as estimated electrostriction contribution of -3 ml mole^{-1}, the electron cavity volume is in the range 3 to 14 ml mole^{-1}, as compared to about 100 ml mole^{-1} in liquid ammonia. (auth)

29350 RADIATION INDUCED OXIDATION AND REDUCTION OF IRON IN AQUEOUS SOLUTIONS. PART X. RADIATION INDUCED REACTIONS IN THE AQUEOUS FERROUS–NITRATE SYSTEM. Broszkiewicz, Roman K. (Univ. of Warsaw. Inst. of Nuclear Research, Warsaw). Nukleonika; 14: 1131-9(1969).

The radioinduced reactions in aqueous solutions containing Fe^{2+} or Fe^{3+} and HNO_3 were investigated. The solutions were saturated with oxygen or deoxygenated. In some cases isobutyl alcohol was added. Depending on the composition of the system, oxidation of Fe^{2+} or reduction of Fe^{3+} were observed as well as the formation of NO_2^-. Comparison of the experimental yields with those calculated on the basis of the competitive reactions seems to confirm the proposed scheme of reactions. The reaction $Fe^{2+} + NO_2 = Fe^{3+} + NO_2^-$ constitutes an important component of that scheme. (auth)

29351 EFFECTS OF CARRIERS AND RADIOLYTICAL CHLORINE ON THE VALENCY FORMS OF RADIOIODINE FORMED IN PROTON IRRADIATED CESIUM CHLORIDE. Dema, I. (Inst. of Atomic Physics, Bucharest); Zaitseva, Natalia G. Rev. Roum. Phys.; 14: 1283-5(1969).

Investigations of the chemical effects of nuclear transformations in solids showed that the presence of crystal defects and their interactions with recoil atoms play an important role in the chemical forms of radioactive atoms and in their annealing reactions. Previous investigations of the chemical behavior of radioiodine recoil atoms formed by spallation reactions indicate that the radiolytical chlorine formed during irradiation of cesium chloride targets has an oxidizing effect on the lower valency states of radioiodine. It was also observed that by dissolving the irradiated crystals in water in the presence of carriers the yield of radioiodine in higher valency states decreases the influence of both carriers and chlorine on the fate of recoiling radioiodine formed in cesium chloride lattice by proton irradiation is quantitatively demonstrated. (auth)

29352 APPLICATION OF A CALORIMETRIC METHOD IN RADIATION-INDUCED POLYMERIZATIONS. I. DETERMINATION OF PROPAGATION AND TERMINATION RATE CONSTANTS FOR METHYL METHACRYLATE. Palma, G.; Busulini, L.; Lora, S. (CNR, Bologna). Eur. Polym. J.; 6: 453-70(1970).

A calorimetric method, in which a thermistor was the temperature sensitive element, was adapted for following the nonstationary states of the polymerization of methyl methacrylate, induced by γ rays. A polymerization rate dependence on (dose rate)$^{\frac{1}{2}}$ was found over the approximate range from 0.2 to 20 rad/sec and at temperatures between -25 and 55°C. Values of the ratio of the propagation to termination rate constants were determined in this range of temperatures by following the initial and final nonstationary states, immediately after the irradiation is abruptly started or reduced. Using values of the initiation rates, determined by means of the DPPH inhibition method, the individual values of the rate constants were obtained. They obey closely the Arrhenius law over the range of temperature investigated. (auth)

29353 KINETIC STUDY OF THE PHOTOSENSITIZED ELECTRON EXCHANGE REACTION BETWEEN URANIUM(IV) AND URANIUM(VI) IN HYDROCHLORIC ACID. Kato, Yasuyoshi; Fukutomi, Hiroshi (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 90, 1-7(Mar 1969).

The electron exchange reactions between U(IV) and U(VI) in HCl, which were previously studied in darkness, were determined under illumination of a Hg lamp. The rate of reaction was accelerated by ~600 times under the irradiation by the Hg lamp and the rate equation had a fractional order with respect to U(IV) and U(VI). Apparent activation energy in the present study decreases to ~60% of that in the darkness. (auth) (NSA of Japan)

29354 PRODUCTION OF ^{46}Sc BY THE (n,p) REACTION. Hernandez Lopez, F.; Barrachina Gomez, M. (Junta de Energia Nuclear, Madrid). An. Quim.; 64: 811-18(Sep-Oct 1968). (In Spanish).

A new method for reactor production of ^{46}Sc by the ^{46}Ti(n,p)^{46}Sc reaction is described. ^{46}Sc separation from Ti target is carried out by 0.3M bis-(2-ethyl hexyl) phosphate (in toluene) extraction in 1M $H_2SO_4-H_2O_2$ medium. ^{46}Sc is recovered from the organic phase using K_2CO_3 solution. Finally ^{46}Sc is separated from K by 100% tributyl phosphate extraction in 10M HCl, after which it is back-extracted with diluted acid. The main characteristics of the radioactive product obtained are: recovery yield ≅98%, specific activity >40 Ci/g, and nuclear yield ≅0.4 mCi/g. (auth)

Radiochemistry

Refer also to abstract 29314.

29355 MEASUREMENT OF THE ADSORPTION OF TRITIUM-LABELLED SODIUM STEARATE AT AIR/WATER INTERFACE USING THIN-WINDOWED GEIGER–MUELLER COUNTER TUBE. Sekine, Keiichi; Seimiya, Tsutomu; Sasaki, Tsunetaka (Tokyo Metropolitan Univ.). Bull. Chem. Soc. Jap.; 43: 629-32(Mar 1970).

The adsorption of tritium-labeled sodium stearate at various pH values and temperatures was directly measured by using a thin end-windowed Geiger–Müller counter. The disturbances due to the application of high electrical potential and the introduction of counting gas, which are inevitably encountered in an ordinary windowless 2π counter, were avoided. Precautions were taken to avoid both surface evaporation effect and contamination of solution due to the absorption of carbon dioxide from the air. The results show that free stearic acid is considered to be the main surface active species in an aqueous sodium stearate. (auth)

29356 CATION-EXCHANGE SEPARATION OF NITROSYL-RUTHENIUM(III) FROM RUTHENIUM(III AND IV) AND ITS RADIOCHEMICAL APPLICATIONS. Miki, Eiichi; Ishimori, Tatsujiro; Okuno, Hisateru (Rikkyo Univ., Tokyo). Bull. Chem. Soc. Jap.; 43: 782-6(Mar 1970).

The cation exchange separation was made on a 0.1M perchloric acid solution of the evaporated residue of a hydrochloric acid solution which contained nitrosylruthenium(III) of 10 mg to 100 μg Ru and ruthenium(III and IV) of 100 to 10 μg Ru; the nitrosylruthenium species were eluted by the use of 80 to 90 ml of 0.1M perchloric acid, and the ruthenium species, by the use of 100 ml of 3M hydrochloric acid containing 50 vol % ethyl alcohol for the columns (3 to 8 ml) of the HR type. It was found by means of the separation that a ^{106}Ru-nitrosylruthenium tracer can be quantitatively prepared by passing nitric oxide into a hydrochloric acid solution of ^{106}Ru-ruthenium(III and IV). The separation on dipotassium pentachloronitrosylruthenate(III) irradiated by thermal neutrons indicated that the specific activities caused by ^{103}Ru in the ruthenium fractions are a few hundred times as high as those in the nitrosylruthenium fractions. (auth)

Separation Processes

Refer also to abstracts 29173, 29202, 29239, 29308, 29356, 29446, 29447, 29964, 30017, and 30760.

29357 (CEA-CONF-1534) REPROCESSING OF IRRADIATED PLUTONIUM AND URANIUM MIXED OXIDES. Faugeras, P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1969. 34p. (In French). (CONF-691122–3). Dep. CFSTI (U. S. Sales Only).

From 2nd Spanish-French Symposium on Fuel Reprocessing and Plutonium Chemistry, Madrid, Spain.

A study was made in 1968 on the cost of reprocessing as a function of capacity for the irradiated mixed oxides UO_2-PuO_2. An amortization rate of 11% corresponding to a period of 17 years and to a rate of interest of 8% was considered. Several possible improvements to be made on the PUREX process in order to reduce the reprocessing cost were studied. These are continuous shearing and dissolution; reduction in the number of extraction cycles for the separation of U from Pu; simplification of the conditioning operations for U and Pu; automation and automatic chemical control, and rational treatment of fission products solutions. The use of a volatilization process should reduce the cost of processing. Small plant units associated with one or several reactors on the same site seem to be still profit-earning, because of the elimination of transfer and the reduction of plutonium investment. (France)

29358 (CEA-CONF-1536) EXPERIMENTS ON CENTRIFUGAL EXTRACTORS. Tarnero, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1969. 13p. (In French). (CONF-691122–4). Dep. CFSTI (U. S. Sales Only).

From 2nd Spanish-French Symposium on Fuel Reprocessing and Plutonium Chemistry, Madrid, Spain.

A set of experiments on uranium extraction and reextraction conditions was performed on a centrifugal extractor. Raffinates containing U from 0.1 to 0.5 mg · l^{-1} could be obtained easily from uranium inputs of 90 and 180 g · l^{-1}. An undesirable effect of an increase in the rotational speed and a good effect of an increase in the total flow rate were observed. With inputs equal to 400 g · l^{-1} the stages were tightened in order to reduce the leaks that cause charged aqueous phases to pollute the raffinates. These leaks become more significant when the rotational speed increases but could be reduced by using the extractors of large diameter. An excess amount of reductor was found to be necessary in the reducing reextractions of cerium(IV). The hydrodynamic behavior was satisfactory with flow-rate ratios of solvent to aqueous phase up to 29. But the plutonium extractions should be more significant. Experiments were also made on precipitate formation from fission zirconium and from solvent degradation products. Only a small amount of precipitate was found to discharge into the aqueous phase; a larger amount was accumulated in the extractor. (France)

29359 (CEA-CONF-1537) REPROCESSING OF ENRICHED URANIUM ALLOYS BY THE FLUORIDE VOLATILITY PROCESS IN THE HOT FACILITY ATTILA. Bourgeois, M.; Perrot, M.; Rochedereux, Y. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1969. 16p. (In French). (CONF-691122-2). Dep. CFSTI (U. S. Sales Only).

From 2nd Spanish-French Symposium on Fuel Reprocessing and Plutonium Chemistry, Madrid, Spain.

Five tests were carried out on irradiated fuel elements in the hot facility Attila. The operating conditions are described. They include: fuel loading; chlorination and pyrohydrolysis of volatile chlorides; UF_6 fluorination and absorption on NaF; recovery of UF_6; sampling and analysis of solid products. Chlorination rates of 1 and 0.4 kg/h can be obtained at 450°C for the alloys U–Zr and U–Al. The decontamination factors obtained for U are excellent: the activity due to fission products in UF_6 is $\leq 5 \cdot 10^{-8}$ Ci/g U for the first 3 tests and equal to $6.3 \cdot 10^{-7}$ Ci/g for the A_5 test. The uranium loss was high for the tests A_3–A_4 as a whole (8.5%). The uranium loss in fluidized bed (1%) and in filter (0.6%) represents only uranium contents of 90 and 120 ppM in alumina. The major portion of the ^{85}Kr formed in the chlorination-pyrohydrolysis of chlorides was eliminated and the presence of ^{131}I and ^{125}Sb was observed. But ^{95}Zr and ^{95}Nb could not be detected. No disposal of radioactive compounds could be observed in gaseous effluents through the fluorination-absorption of UF_6 on NaF. Nearly all the fission products (Ru, Cs, Ce) remain in the reactor alumina for the tests made on cooled fuel. Only Ru is distributed over the reactor and the static bed filter if testing is effected on slightly cooled fuel. (France)

29360 (CEA-R-3976) SEPARATION OF THE TRANSPLUTONIUM AND LANTHANIDE GROUPS ON ANION EXCHANGE RESINS IN THE AMMONIUM THIOCYANATE–PROPANOL–WATER SYSTEM. Kwinta, Jean; Michel, Jean-Jacques (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). May 1970. 35p. (In French). Dep. CFSTI (U. S. Sales Only).

Trace amounts of transplutonium elements are separated on anion exchange resins from elements of the lanthanide group used as tracers or carriers. The separation process is based on the differences in the stabilities of the complexes formed by the two groups of elements with thiocyanate ions in a water–propanol mixture. (France)

29361 (CEA-R-4004) RARE-EARTH EXTRACTION USING DI-2-ETHYL HEXYLPHOSPHORIC ACID. Gusmini, Simone; Nonnenmacher, Rene (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). May 1970. 31p. (In French). Dep. CFSTI (U. S. Sales Only).

The extraction of rare earths with bis(2-ethylhexyl) phosphate (D_2EHPA) was studied. The influence of the aqueous phase (acidity and nature), the time of agitation, the concentration of D_2EHPA in the organic phase and the nature of the diluent were examined. The nature of the acid has only a small influence. The kinetics of the reaction is rapid. An ion-association phenomenon occurs at high acid molarities. (France)

29362 (DOCKET-50201-34) WEST VALLEY REPROCESSING PLANT. Quarterly Report, July 1–September 30, 1969. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 21 Oct 1969. 14p. (SRO-344-6). Dep. CFSTI.

Processing operations, disposition of nuclear material in fuel at the plant, radioactive waste, environmental monitoring, and facility performance and modification are discussed. (M.C.G.)

29363 (DOCKET-50201-35) WEST VALLEY REPROCESSING PLANT. Quarterly Report, October 1–December 31, 1969. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 21 Jan 1970. 13p. (SRO-344-7). Dep. CFSTI.

Processing operations, disposition of nuclear material in fuel at the processing plant, environmental monitoring, radioactive waste, and facility performance and modification are discussed. (M.C.G.)

29364 (ORNL-tr-2302) DEVELOPMENT WORK ON REPROCESSING OF THORIUM NUCLEAR FUELS. (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau (West Germany)). Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Designation St N 111-66, Report 3. 11p. Dep. CFSTI.

A furnace for combustion of spheres was constructed and tested in several experiments totalling 40 hr. It was found that graphite spheres can be burned in a shaft furnace in a stream of oxygen. Ninety percent of the total carbon is burned. By an afterburning process the carbon content of the ash is reduced to less than 0.5%. Results with graphite-coated ThO_2–UO_2 particles are reported. (M.C.G.)

29365 EXTRACTION CHROMATOGRAPHIC SEPARATION OF PLUTONIUM(III), URANIUM(IV), AND URANIUM(VI). Schmid, Erich R. (Univ., Vienna). Microchim. Acta; No. 2, 301-12(1970). (In German).

An extraction-chromatographic separation of the ions plutonium-(III), uranium(IV), and uranium(VI) from each other is described. Tri-n-butyl phosphate (TBP) on a carrier material made from polytrifluorochloroethylene was employed as the stationary phase while nitric acid/hydrazine served as the mobile phase. The stability of uranium(IV), of plutonium(III), and the column under the conditions of the separation were studied, as well as the influence of the acid concentration and the elution rate, on the effectiveness of the separation, and also the behavior of other constituents of the solution. The few manipulations necessary for accomplishing the separation are simple, which constitutes an advantage for working in a glove box. (auth)

29366 EFFECT OF OVERPOTENTIAL ON THE TEMPERATURE DEPENDENCE OF THE ELECTROLYTIC HYDROGEN–DEUTERIUM SEPARATION FACTOR ON PLATINUM. Hammerli, M.; Mislan, J. P.; Olmstead, W. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Electrochem. Soc.; 117: 751-7(Jun 1970).

The temperature dependence of the electrolytic hydrogen–deuterium separation factor, S_D, was studied on bright platinum bead electrodes as a function of overpotential in 1.2N HCl–10% D_2O over the temperature range of 2° to 80°C. S_D decreased with increasing temperature at a given overpotential. At each temperature, S_D increased as the overpotential corrected for IR-drop, η_{corr}, increased from $|-25$ mV| to about $|-300$ mV|; from -300 mV to about -500 mV, the experimental limit, (which corresponds to $\eta_{appl} = 1.2$V) S remained constant within the ±5% reproducibility of the measurements. This behavior is attributed to a possible change in the mechanism of the hydrogen evolution reaction as $|\eta|$ is increased. The temperature coefficient of S_D is independent of η_{corr} within the experimental error. The Arrhenius activation energy difference between the hydrogen–deuterium and the hydrogen producing reactions, ΔE_A, is positive; ΔE_A decreases as $|\eta_{corr}|$ increases, but reaches a plateau value for $\eta_{corr} \geq |-300$ mV|. Conversely, the Arrhenius pre-exponential factor ratio, A_{H_2}/A_{HD}, increases over the same range of overpotentials before reaching a plateau value for $\eta_{corr} \geq |-300$ mV|. Comparison with published work is made. (auth)

29367 SYNERGISTIC EFFECT IN SOLVENT EXTRACTION. RARE EARTH β–DIKETONATE SYSTEM. Shigematsu, Tsunenobu; Honjyo, Takaharu (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ.; 47: 613-27(Nov. 1969).

Synergistic effects of some organic Lewis bases on the extraction of rare earth β-diketonates were studied. The stability constants of the adducts were determined by the curve-fitting method. The effect of the temperature on the adduct formation was estimated. The results are discussed in relation to the ionic radius of rare earth elements, the steric effect and the inductive effect of the functional groups of β-diketones, the dielectric constant of the solvent, and the solubility of water in the organic solvent. As the ionic radius increases, the stability of rare earth benzoyltrifluoroacetonate decreases but that of the adducts increases. Although the overall stability constant of the adduct increases in the following order: lutetium < terbium < europium < lanthanum, the first stability constant does not show such a distinct sequence. Therefore, the contribution of the second stability constant seems to be an important factor. The maximum number of the base bonding to one molecule of rare earth benzoyltrifluoroacetonate is 2, except that in the case of lutetium adduct with TOPO (trioctylphosphine oxide), where the formation of secondary adducts is not observed. The adduct formation is carried out successively. Organic bases studied form stable adducts with rare earth benzoyl-

trifluoroacetonates in the following order: n-hexyl alcohol < TBP TOPO. This order corresponds to the donating power of lone pair electrons of the oxygen atoms in these compounds. The stability of the adduct increases, and larger synergism appears, as aliphatic groups, aromatic groups, and fluoromethyl groups are successively substituted for the functional groups of β-diketones. This effect may be due to the electron withdrawing effect of the fluoromethyl group and conjugation effect (with a metal chelate ring) of the phenyl group. The steric hindrance of the terminal groups is hardly recognized. The extraction constant of the chelates increases, while the stability constant of the adducts decreases, with a rise in the temperature. The binding energy between lutetium β-diketonates and TOPO is nearly equivalent to that of hydrogen bonding. The first stability of lutetium benzoyltrifluoroacetonate adduct with TOPO is higher when the solvent has a smaller dielectric constant and a lower solubility of water. However, the stability constant of the second adduct of lutetium chelate is independent of such properties of the solvents. The change in the solvation energy of inert solvent which is attributed to the interaction of the solvent molecules with the reaction chemical species may play an important role in the adduct formation. (auth)

29368 SEPARATION OF SCANDIUM FROM CHLORIDE SOLUTIONS BY TRIBUTYL PHOSPHATE. Favorskaya, L. V.; Presnetsova, V. A.; Putilin, Yu. M.; Baibekov, M. K.; Vorob'ev, L. I.; Chikodanov, A. I. (Research Inst. of Mineral Resources, Alma-Ata, USSR). Zh. Prikl. Khim.; 43: 1158-60(May 1970). (In Russian).

Scandium extraction from iron chlorides and various mixed chlorides by TBP showed excellent results. Hydroxides reextracted from salt solutions contained 20 to 30% Sc_2O_3. The increase of scandium concentration in the hydrate products of more than 1000 fold indicated the efficiency of TBP extraction. (R.V.J.)

29369 SYNERGISTIC EFFECT IN SOLVENT EXTRACTION. EFFECT OF THE CHELATING LIGANDS ON THE STABILITY OF LUTETIUM MIXED CHELATES WITH β-DIKETONES AND THEIR ADDUCTS WITH TOPO. Shigematsu, Tsunenobu; Honjyo, Takaharu (Kyoto Univ.). Bull. Chem. Soc. Jap.; 43° 796-800(Mar 1970).

The effect of the chelating ligands on the stability of mixed chelates of lutetium with β-diketones and the stability of their adducts with TOPO (trioctylphosphine oxide) in benzene was studied by extracting lutetium with mixtures of two β-diketones, benzoylacetone (BzA) indexed as 1-phenyl-1,3-butanedione) and dibenzoylmethane (DBM) indexed as 1,3-diphenyl-1,3-propenedione), and benzoylacetone and benzoyltrifluoroacetone (BFA) indexed as 4,4,4-trifluoro-1-phenyl-1,3,-butanedione), in the absence or in the presence of TOPO. The extraction constants of Lu–BzA–DBM mixed chelates are almost the same as statistically calculated, while those of Lu–BzA–BFA mixed chelates are somewhat lower than the theoretical values. The stability of the TOPO adducts of the mixed chelates increases in the order, $M(BzA)_2(DBM) \approx M(BzA)(DBM)_2 < M(BzA)_2(BFA) < M(BzA)(BFA)_2$, which is almost the same as that found among the extraction constants of the mixed chelates. The fluoromethyl group stabilizes the adduct more than the phenyl group. All the mixed chelates of lutetium β-diketonates bind one molecule of TOPO per metal chelate. (auth)

29370 ^{125}Sb PRODUCTS FORMED IN THE NEUTRON ACTIVATION OF PHENYLTIN COMPOUNDS. Wheeler, O. H.; Trabal, J. E. (Puerto Rico Nuclear Center, Mayaguez). Int. J. Appl. Radiat. Isotop.; 21: 241-4(Apr 1970).

The ^{125}Sb species resulting from the β-decay of ^{125}Sn formed on activation of organotin compounds were investigated. The compounds used were the stable phenyltin derivatives, tetraphenyltin, triphenyltin chloride, diphenyltin dichloride, and phenyltin trichloride. The antimony-125 products were separated by chromatography on a column of alumina. (auth) (UK)

29371 SELECTIVITY OF EXTRACTANTS FOR METALS. McKay, H. A. C. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Chem. Ind. (London); No. 19, 610-16(9 May 1970).

Flowsheet design and the mathematics of multistage processes for metal extraction are discussed and the problems involved are expressed algebraically. A number of the parameters involved are considered and compromises needed to achieve economical working among a number of conflicting requirements are suggested. The effect of chemical bond energy is discussed particularly in relation to lanthanides and actinides. The separation of rare earths is examined in some detail. (UK)

29372 CHEMISTRY OF THE ELECTROMAGNETICALLY SEPARATED STABLE ISOTOPES. Isotop. Radiat. Technol.; 7: 378-80(Summer 1970).

A purification method for stable isotopes of tungsten electromagnetically enriched at Oak Ridge National Laboratory is described. Tungsten oxide from the ignition of graphite collection pockets is dissolved in ammonium hydroxide and then precipitated as tungstic acid with concentrated nitric acid. Residual tungsten in the filtrate is recovered by precipitation with cinchonine. The combined precipitates are ignited to WO_3, the stable inventory form. (auth)

29373 SEPARATION OF URANIUM BY MEANS OF ION EXCHANGE RESINS IN ORGANIC MEDIUM. Petrement, J.; Lopez, J.; Burriel, F. (Junta de Energia Nuclear, Madrid). An. Quim.; 64: 1053-64(Dec 1968). (In Spanish).

Following the separation by liquid–liquid extraction with a mixed organic solvent (20 v/o TBP–isobutyl methyl ketone of CCl_4), the fixation of uranium on a cationic exchange resin (Dowex 50WX8) was investigated in ternary mixtures with ethyl alcohol and water. Uranium distribution coefficients for various compositions of the system were determined. This procedure was used for determining uranium in uranium concentrates after extraction with organic solvents, the main advantage being the separation of uranium from the mixture of organic solvent–nitric acid in a single step. After elution, the uranium concentration is measured by redox titration. Statistical analysis shows that the accuracy of this method is higher than that obtained by conventional procedures of uranium analysis. (auth)

29374 ION EXCHANGE PROPERTIES OF TIN(IV) MATERIALS. III. ANION EXCHANGE AND FURTHER CATION EXCHANGE STUDIES ON HYDROUS TIN(IV) OXIDE. Donaldson, J. D. (Chelsea Coll. of Science and Tech., Eng.); Fuller, M. J. J. Inorg. Nucl. Chem.; 32: 1703-10(May 1970).

The sorption of alkali and alkaline earth cations on hydrous tin(IV) oxide was investigated (in particular on the exchanger in the NH_4^+ form) and some chromatographic separations among these ions are described. The use of the exchanger in the H^+ form to remove UO_2(II) and transition metal ion contamination from solutions containing large amounts of the above ions was also investigated. Some anion-exchange properties of this material are also reported, and the marked selectivity series established predicts the possibility of easy separations of certain anionic species on columns of hydrous SnO_2. (auth) (UK)

29375 THERMODYNAMICS OF THE TWO-PHASE SYSTEM: WATER–URANYL NITRATE–TRIBUTYL PHOSPHATE–AMSCO 125-82. Davis, W. Jr.; Mrochek, J.; Judkins, R. R. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 32: 1689-1702 (May 1970).

New experimental data are presented for the distribution of uranyl nitrate and water between an aqueous phase and an organic phase containing 5 to 100 vol % tributyl phosphate (TBP) in an odorless kerosene-like diluent (Amsco 125-82). The uranyl nitrate equilibrium constant is expressed as an equation in the two independent variables of the organic phase. When the data are fitted to this equation subject to the condition that the relative standard deviation be a minimum, then the deviation between the observed and the calculated uranium concentration in the organic phase is 5 per cent of the observed value. An equation to represent the densities of the organic phases is also presented. Assuming the molar volume of water to be constant at 18 ml/mole, the molar volumes of the components in the organic phase, in ml/mole, were calculated to be: 273.1 for TBP, 246.8 for the diluent (whose molecular weight was assumed to be 185), and 93.5 for $UO_2(NO_3)_2$. A comparison of the variation of activities of TBP in diluent-free HNO_3 systems with those in $UO_2(NO_3)_2$ systems suggests that the extracted species is $HNO_3 \cdot 2TBP$ when the loading of TBP is less than 0.5 mole HNO_3 per mole of TBP. (auth) (UK)

29376 ELECTROPHORESIS OF THE LANTHANIDES, Y, Sc, Th, U, AND Zr IN LACTIC ACID. Moura, M. Manuela L.; de Carvalho, R. Guedes (Central Inst. of Nuclear Chemistry, Porto, Portugal). Rev. Port. Quim. (Lisbon); 11: Nos. 1-4, 22-5(1969). (In Portuguese).

The best conditions for lanthanide separation by electrophoresis in lactic acid were determined. Mobilities and separations of the lanthanides, Y, Sc, Th, U, and Zr were performed in 0.7M lactic acid. The results are compared with those obtained using glycolic acid. (auth)

29377 METHOD OF TANTALUM AND NIOBIUM RECOVERY FROM THEIR SOLUTIONS. Zverev, L. V.; Petrova, N. V.; Basov, A. S.; Zelikman, A. N.; Sobinyakov, N. M. (to All-Union Scientific Research Inst. of Mineral Raw Materials). Russian Patent 225,454. 30 Jun 1969. Filed 17 Aug 1966. (In Russian).

The water-soluble amine complexes of Ta and Nb are treated with a mixture of tributyl-phosphate and 10% solution of the quaternary ammonium base salt (dimethylalkylbenzylammonium chloride) in kerosene. Under this treatment both Ta and Nb are converted from monoethanolamine solution into an extracting

agent. Separation of soil acids is attained at the reextraction stage. At the outset of saturation with oxalic acid solution Nb is reextracted, and later, with 100 g/liter NH_4F, Ta is reextracted. Thus, from monoethanolamine solution with a Nb and Ta content ratio of 10:1, Nb_2O_5 is obtained containing 0.5% Ta_2O_5 and practically no Nb. (JPRS)

29378 SIMPLIFIED AND GENERALIZED METHOD FOR ANALYZING CHROMATOGRAPHIC ISOTOPE SEPARATION DATA. Kakihana, Hidetake; Kanzaki, Tadao (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 90, 77-89(Mar 1969).

A simplified and generalized equation for analyzing isotope separation data experimentally obtained by electromigration and ion-exchange chromatography was derived: $S \equiv 1 + \epsilon = 1 + D/Q \cdot 1/R_0$, where ϵ and S are the relative difference in migration velocity of isotopes and the single stage, elementary, separation factor, respectively, Q is the isotropic total capacity of the ion-exchange membrane or the ion-exchange column of migration length, D is the depleted amount of isotope M_1 at the rear or frontal part of the adsorbed band of isotopes or the enriched amount of isotope M_1 in the ion exchanger after operation. $1 + \epsilon$ and S given by the above equation have exactly the same physical meaning and make possible the mutual comparison of the two isotope separation processes: the electromigration and the ion-exchange chromatography. (auth) (NSA of Japan)

29379 PAINTS FOR NUCLEAR PLANTS. Putti, Giuseppe. Com. Naz. Energ. Nucl., Notiz.; 16: No. 4, 75-8(Apr 1970). (In Italian).

The various types of paints used in nuclear plants are discussed, together with their main characteristics and performance specifications. The effects of radiation and decontamination are discussed. (auth)

29380 SEPARATION OF THE STABLE ISOTOPES OF NITROGEN BY ION EXCHANGE. I. DETERMINATION OF SEPARATION FACTORS. Carrillo, D.; Urgell, M.; Iglesias, J. (Junta de Energia Nuclear, Madrid). An. Quim.; 64: 841-6(Sep-Oct 1968). (In Spanish).

The isotopic separation factor of the stable nitrogen isotopes in ammonia, n-butyl-amine, dimethylaminoethanol, and triethylamine as a function of temperature was determined. The frontal analysis chromatographic method (break-through technique) on a column containing a strong acid cation exchange resin in the hydrogen form was used. The isotopic separation factor $K(= 1 + \epsilon)$ was measured from 25 to 70°C and found to decrease from: 1.0254 to 1.0192 ammonia, 1.0226 to 1.0152 in n-butylamine, 1.0139 to 1.0083 in dimethylaminoethanol, and 1.0123 to 1.0060 in triethylamine. A plot of $\ln \epsilon$ against $1/T$ have given straight lines in all the cases. The heat of exchange and the entropy of the isotopic equilibrium were calculated. The values for the ammonia were calculated to be $\Delta H^0 = -23.91$ cal/mole and $\Delta S^0 = -3.15 \times 10^{-2}$ cal/mole-grade, for the n-butylamine $\Delta H^0 = -30.68$ cal/mole and $\Delta S^0 = -5.98 \times 10^{-2}$ cal/mole-grade, for the dimethylaminoethanol $\Delta H^0 = -23.64$ cal/mole and $\Delta S^0 = -5.19 \times 10^{-2}$ cal/mole-grade and for the triethylamine ΔH^0 −25.88 cal/mole and $\Delta S^0 = -6.27 \times 10^{-2}$ cal/mole-grade. The heat of exchange was calculated at 25 to 70°C, while the entropy was calculated at 25°C. (auth)

29381 SEPARATION OF THE STABLE ISOTOPES OF NITROGEN BY ION EXCHANGE. II. CHOICE AND BEHAVIOR OF BINARY SYSTEMS. Carrillo, D.; Urgell, M.; Iglesias, J. (Junta de Energia Nuclear, Madrid). An. Quim.; 64: 847-54(Sep-Oct 1968). (In Spanish).

In an effort to develop a procedure for the separation of stable nitrogen isotopes by means of ion exchange, the behavior of the binary systems, ammonia–dimethylaminoethanol, ethylenediamine–trimethylamine and n-butylamine–triethylamine was studied on Dowex 50W resin with 2, 4, 8, and 12% divinylbenzene (DVB) at 15 and 70°C. In each one of the selected systems, one of the bases has a constant of basicity greater than the other one at 15°C ($Kb_1 > Kb_2$), but at 70°C the ratio turns upside down ($Kb_1 < Kb_2$). For this reason reciprocal displacements on the ion exchanger at the given temperatures can be expected. This theory was borne out experimentally in the three systems. At greater percentages of DVB the displacement fronts are gradually extended, possibly due to a steric effect. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 29414, 29451, 30438, and 30672.

29382 (CSIRO-Trans-9993) SOLUTION OF THE DIRECT PROBLEM OF NEUTRON GAMMA LOGGING BY A MONTE CARLO METHOD. Dyad'kin, I. G.; Starikov, V. N.; Enikeeva, F. Kh. Translated by B. Bergmanis from Neftegazov. Geol. Geofiz.; 10: 40-1(1968). 4p. Dep. CFSTI (U. S. Sales Only).

An algorithm to reduce time spent in examining the behavior of the dependency curve $\ln\gamma = f(m)$ in the region of low porosities has been produced, taking into account the influence of most basic factors. Thermal neutron diffusion, gamma quanta of non-elastic diffusion, and pair formation influences were not taken into account. This would have been possible, but the influence was considered negligible. The particulars of the algorithm are noted, and details of the dependency of neutron logging readings on the porosity of limestone boreholes are calculated. (Australia)

29383 EROSIONAL BEHAVIOR OF ^{137}Cs. Rogowski, A. S.; Tamura, Tsuneo (Oak Ridge National Lab., Tenn.). Health Phys.; 18: 467-77(May 1970).

Movement of ^{137}Cs by runoff, erosion, and infiltration on a silt-loam soil in Tennessee is reported. A summary of a 2-yr study is given, and a model for the nuclide erosional loss is suggested. It was found that, although an empirical parabolic equation adequately describe the radionuclide loss, an exponential model, based on the nuclide distribution in a soil profile, appear to give more general results. The results show that a 60% reduction in the radiation dose due to surface-deposited ^{137}Cs occurred during the first 7 months following the application. Most of the applied radiocesium was found in the 0- to 3-cm layer or had been eroded away. It appears that the specific loss of ^{137}Cs reflects the seasonal variation in the magnitude of the erosion index and the extent of vegetative cover for a particular location. (auth) (UK)

29384 RADIOGENIC OSMIUM IN RHENIUM-CONTAINING ORES. Esenov, Sh. E.; Egizbaeva, K. E.; Kalinin, S. K.; Fain, E. E. (Inst. of Geological Sciences, Alma-Ata, USSR). Geokhimiya: No. 5, 610-15(May 1970). (In Russian).

The problem of distribution of radiogenic osmium (^{187}Os) originating in ores and minerals as a result of decay of one of the rhenium isotopes was studied. Content of the ^{187}Os isotope in rhenium-containing ores in copper and copper-molybdenum deposits was determined by means of the spectrographic method. The ^{187}Os/Re ratio in ores varied in the ranges from 1 : 170 to 1 : 2200. The problem of applying the rhenium-osmium method for determination of the absolute geological age of ore deposits is being discussed. (auth)

29385 THERMOLUMINESCENT DOSIMETRY OF ENVIRONMENTAL RADIATION ON ARCHAEOLOGICAL SITES. Aitkin, M. J. Archaeometry; 11: 109-14(1969).

The errors arising from inaccurate measurement of the environmental background when using the inclusion method of dating are discussed. To overcome difficulties experienced in measuring this background, long term in situ measurements with thermoluminescent dosimeters (TLD) were used. A high sensitivity phosphor with long term stability was incorporated in the equipment. The field procedure is described and the results discussed. (UK)

29386 RECENT APPLICATIONS AND DEVELOPMENTS IN THERMOLUMINESCENT DATING. Zimmerman, D. W.; Huxtable, J. Archaeometry; 11: 105-8(1969).

The errors expected in dating shards by thermoluminescence using the fine grain technique are discussed. These errors, arising primarily from attenuation of radiation by ground water and from radon-thoron emanation, give dating errors in opposite directions. Dating results are given so that the degree of usefulness of the method in practical situations can be assessed. (UK)

29387 THERMOLUMINESCENCE DATING OF ANCIENT DANISH CERAMICS. Mejdahe, V. (Danish Atomic Energy Commission, Riso, Denmark). Archaeometry; 11: 99-104 (1969).

Previous work (NSA 23: 7860) described the method of dating shards by separation of large mineral inclusions for measurement of the natural TL. In that work an average value of 0.080 R/yr was assumed as natural background but recent measurements have indicated a wide variation (0.060 to 0.200 R/yr) from one site to another. The measurement methods used for detection of the radiation emitted by radioisotopes imbedded in the shards, of the TL of the shards and of the environmental radiation, are described and revised data for Danish shards from the Iron Age, 500 BC to AD 500 are presented. It is stressed that the environment radiation, which may contribute up to 70% of the total exposure of a shard, must be carefully measured at the exact location of the shard at the excavation site, preferably during excavation. (UK)

Meteorology

Refer also to abstracts 29308 and 29498.

29388 (AD-702523) STUDIES TO DETERMINE THE FEASIBILITY OF MEASURING AIRBORNE DEBRIS IN DUST AND HOT GAS ENVIRONMENTS USING AN INFRARED SCANNING CAMERA. Final Report, March 1-August 31, 1969. Lieberman, Paul; Raisen, Elliott (IIT Research Inst., Chicago, Ill.). 12 Sep 1969. Contract DASA01-69-C-0097. 101p. (IITRI-J-6172-FR; DASA-2400). CFSTI.

Descriptions are given of the theory for the absorption and scattering of electromagnetic energy by a dielectric particle, gas molecules, non-disperse clouds of the same particle material size, clouds having specified distribution of particle sizes, and clouds of particles in air. The analysis is specialized to consider the transmission of images through the fine particles and hot gases generated by the detonation products of a TNT explosion, as detected by visible light and infrared wavelength photography. The theory is further expanded to include discussion of the detection of objects in the explosion products by the emission and reflection of infrared energy from the object. A BOFORS Model T-101 infrared scanning camera with a frame speed of four frames per second was used to obtain infrared pictures of targets in the 1.0- to 5.5-micron wavelength region in laboratory tests, cloud chamber tests, and in 2-pound TNT explosives tests. Target pictures were enhanced by the use of infrared flare illumination, a magnifying mirror and filtration of unwanted background. (auth) (USGRDR)

29389 (CEX-67.6.2) HUMBOLDT BAY ENVIRONMENTAL RADIATION SURVEY (ARMS-II). Hand, J. E.; Weissman, V. F. (EG and G, Inc., Las Vegas, Nev.). Nov 1968. 39p. Dep. CFSTI.

The operational power reactor at Humboldt Bay, California, and the surrounding site were surveyed from the air during normal operation, following shutdown, and after restart of the reactor. Radioactive noble gases and their daughters can be found many miles from the operational site during the course of normal operating conditions. The effluent appears to meander widely and to disperse homogeneously to altitudes of at least 3,000 to 4,000 feet above the terrain at large distances from the reactor. Under certain atmospheric conditions, effluents can be detected at the terrain level and their trajectories plotted using hand-held detectors. During the course of the measurements reported, dose rates as high as 190 μR/hr were found at ground level a mile or so from the reactor stack. Gamma spectra taken at the ground level verified the presence of airborne fission products at the points of high readings. Gamma spectral data collected over one location, approximately 5 miles from the plant, indicated the presence of ^{140}Ba-^{140}La. At the time of the measurements, the ground dose rate level from the ^{140}Ba-^{140}La was no greater than 40% of the natural background. Since the measurements were made close to one half-life of the ^{140}Ba parent following shutdown, the daily equilibrium level of the ^{140}Ba-^{140}La pair when the reactor is running would be expected to be approximately twice that found during these measurements. Following restart of the reactor, gamma spectral data were collected in the effluent area downwind of the reactor exhaust stack to provide a gamma radiation signature of the effluent. Periodic flights along a similar route in the future will permit comparisons to be made of the effluent characteristics and provide a means of monitoring the reactor exhaust filtering effectiveness. (J.C.W.)

29390 (COO-2053-1) GASEOUS PLUME DIFFUSION ABOUT ISOLATED STRUCTURES OF SIMPLE GEOMETRY. Annual Progress Report, June 14, 1969-June 14, 1970. Meroney, Robert N. (Colorado State Univ., Fort Collins. Engineering Research Center). Mar 1970. Contract AT(11-1)-2053. 18p. Dep. CFSTI.

A model was constructed to perform geometrically and dynamically similar experiments for diffusion of gases in building wakes in the atmosphere and in the meteorological wind tunnel. Kr-85 was used as a tracer gas for obtaining concentration dis-

tributions. Dispersion of the gas was affected by the aerodynamic structure of the flow and the temperature stratification condition. Photographs showed a strong mixing in the cavity region and a turbulent mixing motion was dominant in the wake region. The apparatus allowed different places for release of the smoke, and similar contours of concentration distribution showed no effect of the release location. The stable stratified flow suppressed the turbulent motion and resulted in higher concentrations at a given down wind distance. (J.C.W.)

29391 (LA–4388) BETA RADIOACTIVITY IN ENVIRONMENTAL AIR AND PRECIPITATION AT LOS ALAMOS, NEW MEXICO, FOR 1969. Kennedy, W. R.; Aeby, Jack W. (Los Alamos Scientific Lab., N. Mex.). Jan 1970. Contract W-7405-eng-36. 10p. Dep. CFSTI.

Beta activity of particulate matter in both air and precipitation for 1969 are reported for Los Alamos, New Mexico. The gradually increasing levels in both air and water samples from January through July reflect a contribution from foreign fallout arriving at out station as well as greater than average rainfall. The slight upward trend in October is a normal seasonal upswing. (auth)

29392 (NIRS-RSD–25) RADIOACTIVITY SURVEY DATA IN JAPAN. Number 25. (National Inst. of Radiological Sciences, Chiba (Japan)). Nov 1969. 11p. Dep. CFSTI (U. S. Sales Only).

Radioactivity survey data acquired in Japan are presented and include: May 1968 to October 1969 measurements at 95 locations of gamma radiation exposure rates due to natural radioactivity; the 1947 to 1969 measurements of ^{14}C content in menthol and thymol in botanical plants at several locations; and the Sept. 29 to Oct. 9, 1969 measurements of the gross beta activity in rain, dry fallout and the upper atmosphere. Seismic data on the Sept. 29, 1969, Chinese test explosion are also tabulated. (L.C.L.)

29393 SAMPLING OF RADIOACTIVE DEPOSITION THROUGH ION-EXCHANGE RESINS. De Bortoli, M. C.; Gaglione, P. (EURATOM, Ispra, Italy). Minerva Fisiconucl.; 13: 219–24 (1969).

A collector for radioactive fallout employing a column of ion exchange resins was developed and operated for two years. The comparison between the collection efficiency of the new collector and that of the evaporation collector (pot) shows that they are equivalent. The column collector is equipped with a filter, thus permitting the determination of the undissolved fraction of the radionuclides. This fraction was found to depend on the amount of rain and the correlation equations are given for ^{90}Sr and ^{137}Cs. (Euro. Abstr.)

29394 UPWARD FLUX OF RaB AND RaC IN THE PLANETARY BOUNDARY LAYER AS CONTROLLED BY ATMOSPHERIC MICROSTRUCTURE. Reiter, Reinhold (Fraunhofer-Gesellschaft, Garmisch-Partenkirchen, Ger.). Pure Appl. Geophys.; 72: 247-58(1969/I).

Vertical mixing and transport processes are studied, and their variation as influenced by atmospheric fine-structure conditions investigated, using data gathered from simultaneous measurements of RaB and RaC concentration in the ambient air at three mountain stations located close to each other horizontally, but at markedly differing levels (730, 1780 and 2960 m). RaB was used as a tracer on account of the high sensitivity to variations of vertical-mixing activity evidenced by RaB abundance figures. Strong inversions between 700 and 2500 m above sea level create a "zero condition" at the higher level, where only 0.1% of the low-level RaB reading is found; active turbulent mixing, on the other hand, leads to nearly equal RaB readings at the two levels. The vertical gradient of concentration of RaB is used to compute mean vertical-mass-exchange coefficients; the latter are studied in their relation to atmospheric structure characteristics. Statistical studies results indicate that the barring effect of inversions is related solely to the magnitude of the inverse temperature gradient. Problems of radioactive equilibrium RaB–RaC are discussed, and the significance of aerosol particle size taken into consideration. (auth)

29395 RADIOACTIVE EQUILIBRIUM IN ATMOSPHERIC AEROSOLS AT 700 AND 1800 m a.s.l., AS INFLUENCED BY PARTICLE SIZE AND VERTICAL MIXING ACTIVITY. Reiter, Reinhold (Fraunhofer Gesellschaft, Garmisch-Partenkirchen, Ger.). Pure Appl. Geophys.: 74: 134-44(1969/III).

Data from simultaneous measurements of RaB and RaC concentration in atmospheric aerosols, taken at sites located roughly 700 and 1800 m above sea level are used to elucidate the relation of the ratio of the specific activities of RaB and RaC in aerosol particles on the one hand to the intensity of vertical mixing and the size of the aerosol particles on the other. The empirical relationships as found from a 15-month period of uninterrupted measurements are presented. Radioactive equilibrium is more nearly approached in aerosol particles of more than one micron in diameter than in smaller ones (including the smallest measurable sizes); this holds invariably—and for all height levels. The degree of approach to RaB/RaC equilibrium is the lowest for low altitude (700 m) and negligible vertical mixing: 65 to 75%. At the low-altitude site, this figure increases to 80–90% as the intensity of vertical mixing reaches higher levels. At 1800 m above sea level, the degree of approach to RaB/RaC equilibrium is nearly 100% when vertical mixing is negligible, and declines with increased vertical mixing activity to a level of only 60 to 70% for conditions involving strong vertical mass exchange. (auth)

Mineralogy and Exploration

Refer also to abstract 30123.

29396 (CONF-680972–1) CONSIDERATIONS IN THE STUDY OF URANIUM MINERALS MADE BY OPTICAL AND X-RAY METHODS. Andronescu, A. (Ministry of Mines, Bucharest (Romania)). [1965]. 14p. (In French). Dep. CFSTI (U. S. Sales Only).

From National Conference of Pure and Applied Physiological Chemistry, Bucharest, Rumania.

Optical and x-ray analytical techniques were developed to establish the differences between hypogene minerals of uranium, such as uraninite or pitchblende and the supergene ones, represented by kasolite, uranophane, fourmarierite and masuyite. The structural relationships or uraninite with galena are specific for this uranium mineral and have not been encountered with pitchblende. Interlattice distances of uraninite and pitchblende on Debye–Scherrer diagrams were found to be identical but their lattices were different. The presence of the lines of galena in uraninite diagrams was confirmed also by microscopic observations. The supergene uranium minerals which could not be determined conveniently by microscopic observations, were easily identified on the basis of their Debye–Scherrer diagrams. (TTT)

29397 (GJO–918–1) ENGEL MODEL AS A SIMULATOR OF EXPLORATION PROGRAMS. Griffiths, J. C.; Dahlberg, E. C.; Ondrick, C. W.; Singer, D. A.; Singer, J. A. ([Pennsylvania State Univ., University Park]). Jun 1968. Contract AT(05-1)-918. 16p. Dep. CFSTI.

The Engel mathematical model is designed to represent an exploration program for natural resources; the nature of the model is described and estimation of the twelve parameters which enter the model is discussed. An example of simulations of uranium exploration is given as an illustration of the application of the model. (auth)

29398 (GJO–918–2) SIZE, SHAPE, AND ARRANGEMENT OF SOME URANIUM ORE BODIES. Final Report, Part 2. Griffiths, J. C.; Singer, D. A. (Pennsylvania State Univ., University Park. Coll. of Earth and Mineral Sciences). Dec 1969. Contract AT(05-1)-918. 42p. Dep. CFSTI.

The projected size, shape, and arrangement of target ore bodies are the determinative factors and the procedure used in exploration is analogous to measurement in thin section microscopy. The analysis begins with a definition of the region of interest, and this is reproduced as a map of the ore bodies. The analytical procedure is applied to ore bodies in the Ambrosia Lake region of New Mexico; North Big Indian Wash, Utah; Gas Hills, Wyoming; and Shirley Basin, Wyoming. (J.R.D.)

Oceanography

Refer also to abstract 29720.

29399 (UCSD–34-P-163-X-1) MEASUREMENTS OF BOMB-PRODUCED RADIOCARBON IN THE SURFACE AND SUBSURFACE WATER OF THE PACIFIC OCEAN. Interim Progress Report, March 1, 1970–February 28, 1971. Suess, Hans E. (Scripps Institution of Oceanography, La Jolla, Calif.). 1 Mar 1970. Contract AT(11-1)-34. 17p. Dep. CFSTI.

Data are presented on water sampling in the Pacific Ocean during the Piquero expedition, Dec. 1968 to Mar. 1969; Dragon expedition, June 1969; coast guard Acusnet sampling, May 1969 to Sept. 1969; and Scan expedition, Apr. 1969. (J.R.D.)

Seismology

Refer also to abstract 29392.

29400 (RT/ING–(69)14) STATISTICAL EVALUATION OF EARTHQUAKES IN THREE SITES PROPOSED FOR A NUCLEAR

PLANT. Caputo, M.; Chiarini, A.; Pieri, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 14 May 1969. 24p. (CONF-681224-3). Dep. CFSTI (U. S. Sales Only).

From Conference on Seismic Design Specification for a Nuclear Plant at Brasimone Site, Bologna, Italy.

After some statistical introductory considerations and a critical examination of the seismic information about the three sites Brasimone, Trisaia and Casaccia, the extreme values theory according to Gumbel is applied to the data. The relationship between intensity and magnitude and on the variation of the intensity with epicentral distance with particular reference to the Appennines is discussed. The periods of return and the critical intensity and acceleration for the three sites are examined. (auth)

29401 (RT/ING-(69)22) REPORT ON THE DEFINITION OF THE INTENSITY OF THE "DESIGN EARTHQUAKE" FOR THE PEC PLANT AT BRASIMONE. AN ATTEMPT FOR THE APPLICATION OF AMERICAN AND JAPANESE CRITERIA. Grandori, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 2 Sep 1969. 20p. (CONF-681224-4). Dep. CFSTI (U. S. Sales Only).

From Conference on Seismic Design Specification for a Nuclear Plant at Brasimone Site, Bologna, Italy.

A comparative study of the seismic activity of Brasimone basin (Italy) and of San Onofre (California) was accomplished according to historical data collected on both sites. The criteria established for the structural safety of a nuclear power plant in San Onofre area was applied to Brasimone basin. According to this criterion the maximum ground acceleration in this area was evaluated to be 0.31 g. This value seems to be in good agreement with the value obtained by applying a Japanese safety criterion for nuclear power plant in seismic regions. (auth)

29402 (RT/ING-(69)23) REPORT ON SOME SEISMIC PROBLEMS IN CONNECTION WITH THE DESIGN OF THE PEC REACTOR. Grandori, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 2 Sep 1969. 38p. (CONF-681224-5). Dep. CFSTI (U. S. Sales Only).

From Conference on Seismic Design Specification for a Nuclear Plant at Brasimone Site, Bologna, Italy.

A comparative study of the seismic activity of three sites (Brasimone, Casaccia, and Trisaia) was carried out based on historical data. The modified Mercalli intensity of the earthquakes recorded since 1750 was taken into account. Statistical methods according to extreme values theory were thus applied in order to get design intensities of the three sites. The dynamic behavior, under earthquake-type seismic activity, of a nuclear pressure vessel fabricated in the Brasimone area, was examined. The natural frequencies of oscillation were found to be of the order of 4 to 5 cps. (auth)

29403 (RT/ING-(69)24) STABILITY OF SEISMIC ACTIVITY IN ITALY WITH SPECIAL REFERENCE TO GARFAGNANA, MUGELLO, AND FORLIVESE. Boschi, E.; Caputo, M.; Panza, G. F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 2 Sep 1969. 23p. (CONF-681224-2). Dep. CFSTI (U. S. Sales Only).

From Conference on Seismic Design Specification for a Nuclear Plant at Brasimone Site, Bologna, Italy.

An analysis of available information on Italian seismic activity for the period from 1500 till today is presented. It is shown that the seismicity of many Italian regions is almost constant. Special attention is given to the region Garfagnana, Mugello and Forlivese for which the estimate of return periods for earthquakes of intensity larger than VII is given. The acceleration of the ground is tentatively estimated for earthquakes of intensity ½IX and X with two empirical relations. Finally a comparison is made with the seismicity of California. (auth)

29404 (RT/ING-(69)25) RECOMMENDED SEISMIC DESIGN CRITERIA FOR A NUCLEAR FACILITY AT BRASIMONE, ITALY. Housner, G. W. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 2 Sep 1969. 17p. (CONF-681224-6). Dep. CFSTI (U. S. Sales Only).

From Conference on Seismic Design Specification for a Nuclear Plant at Brasimone Site, Bologna, Italy.

The geological and seismic situation in the Brasimone site is considered and an evaluation of the largest earthquake expected is made. Then, design recommendations are made based on the design spectrum method. (auth)

29405 (RT/ING-(70)1) RECOMMENDED SEISMIC DESIGN CRITERIA FOR A NUCLEAR FACILITY AT BRASIMONE, ITALY. Final Report. Housner, G. W. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 28 Nov 1969. 31p. (CONF-681224-7). Dep. CFSTI (U. S. Sales Only).

From Conference on Seismic Design Specification for a Nuclear Plant at Brasimone Site, Bologna, Italy.

The geological and seismic situation in the Brasimone site is considered and an evaluation of the largest earthquake expected is made. Then, design recommendations based on the design spectrum method are made. An example of the design spectrum method is reported. (auth)

29406 (TID-25363) PRELIMINARY GEOLOGIC ENVIRONMENTAL MAP OF THE GREATER LOS ANGELES AREA, CALIFORNIA. (A STUDY PERTINENT TO NUCLEAR FACILITY SITING AND DESIGN). Wentworth, Carl M.; Ziony, Joseph I.; Buchanan, Jane M. (Geological Survey, Washington, D. C.). 1970. 41p. Dep. CFSTI.

In order to make judgments about the suitability of sites for nuclear reactors and other structures whose safe and reliable operation is critical to the public interest, it is necessary to know the geologic and seismic conditions not only of the site area but also of the surrounding region. Therefore, existing data on the earthquake geology and seismology of the Greater Los Angeles Area, California was compiled to form a map and report on the geologic environment of this region. This map is intended to provide preliminary information on conditions at a given site and should be valuable in the early phases of site selection and considerations of design and construction. The map provides data on: location and displacement of faults, rock and sediment conditions, surface subsidence, past landslides, the adequacy of the available geologic information, and the general physical properties of the earth materials. (L.C.L.)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 29392, 29399, and 29485.

29407 (AD-688512) DESIGN PLAN FOR INVESTIGATING THE ATMOSPHERIC ENVIRONMENT ASSOCIATED WITH HIGH-ALTITUDE NUCLEAR TESTING. Olsen, Robert (Army Electronics Command, White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.). Mar 1969. 40p. (ECOM-5244). CFSTI.

An experimental concept is described for investigating and measuring a number of effects in an atmospheric environment associated with high-altitude nuclear testing. Specifically, these effects include atmospheric temperature and pressure before and after detonation, thermal radiation, over-pressure, shock wave radius time determination, and determination or approximation of the blast wind velocity caused by a nuclear explosion. The ground equipment and payload which have been test-certified for performance are described, and actual test flight certification performance results are summarized. Improvements in overall system capability and reliability of the payload design are described. (auth) (USGRDR)

29408 (AD-690073) ON DETECTION OF AN UNDERGROUND NUCLEAR TEST. Research Communication No. 94. Gauger, Joleroy; Slade, David V. (McDonnell Douglas Corp., Huntington Beach, Calif. Douglas Advanced Research Labs. Royal Australian Air Force Academy, Melbourne); Vali, Victor (Washington Univ., Seattle. Boeing Scientific Research Labs., Seattle, Wash.). Mar 1969. 11p. CFSTI.

Data are presented relating to an underground nuclear test in November 1968. The AEC news release stated that on that day a test took place at the Nevada test grounds. No information regarding size, depth, or time of shot was given. It is hoped to show here the ease with which the time, size, and location of this explosion was found with the instrument to be described. (auth) (USGRDR)

29409 (BM-RI-7391) FRACTURING HARD ROCK WITH NUCLEAR EXPLOSIVES AND EXTRACTION OF ORE BY A MODIFIED BLOCK-CAVING METHOD. Hardwick, William R. (Bureau of Mines, Tucson, Ariz.). Jun 1970. 18p. Dep. CFSTI.

Nuclear explosive fracturing has been suggested as a method to make hard rock amenable to extraction by a modified block-caving method. To evaluate this possibility, conventional and nuclear blasting practices are discussed, underground mining methods for large deposits and their costs are described, and the cost of fracturing ore with a nuclear explosive and subsequent mining by a modified caving system is estimated and compared with both open-stope and block-caving mining costs. While the direct cost of fracturing the ore in hard rock with a nuclear explosive is less than with conventional explosives, additional costs imposed by the use of nuclear explosives may make their use unattractive for deep mining. (auth)

29410 (FOA-4-4338) SEISMOLOGICAL TEST BAN CONTROL. Ericsson, U. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Feb 1968. 36p. Dep. CFSTI (U. S. Sales Only).

A method for determining the usefulness of seismological event identification methods for underground test ban control with or without on-site inspection is described. Applications to published regional and teleseismic identification data are given. (auth)

29411 (NVO-1163-TM-11) ONE-DIMENSIONAL EARTH MOTION CALCULATIONS. Cassity, C. R.; Davis, A. H.; McQuinn, L. D. (Environmental Research Corp., Alexandria, Va.). Apr 1970. Contract AT(29-2)-1163. 24p. Dep. CFSTI.

A one-dimensional computer program which describes spherically symmetric motions following an underground nuclear explosion was developed. Plastic and brittle failure in the earth medium is taken into account. The recent improvements in the program are described, the most important of which is a subroutine which selectively rezones portions of the mesh and selects an optimum time increment. The first results of an extensive parameter study are given, covering the effects of failure criteria, depth of burial, and yield on final cavity radius, cracking radius, and stress profiles. It is recommended that the program be used as an input for a two-dimensional elastic earth motion program, as well as for predictions of close-in effects in forthcoming events. (auth)

29412 (RT/GEN-(69)3) BIBLIOGRAPHY ON UNDERGROUND NUCLEAR EXPLOSIONS (1950-1968). Perilli, M. L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). [1969]. 39p. (In English and Italian). Dep. CFSTI (U. S. Sales Only).

Recent developments in underground nuclear explosion technology and the possibility of their use for peaceful purposes provide the basis for the bibliography. The bibliography reports published works for the period Jan. 1950 to Dec. 1968, and is subdivided into the following periods: Jan. 1950 to Dec. 1965, Jan. 1966 to Dec. 1967, and Jan. to Dec. 1968. Each of the subdivisions is further divided into the following categories: general, description of the explosions, civil engineering applications, mining applications, radioactive contamination, identification (detection), and scientific research and technology. Personal author and organization indexes are provided. (R.C.K.)

29413 (TID-25422) PLOWSHARE PROGRAM DURING 1969. Based on the Annual Report to Congress for 1969. (Atomic Energy Commission, Washington, D. C.). 1970. 10p. GPO $0.15.

A review of 1969 activities is presented including Project Rulison. Other activities such as research on nuclear excavation and special scientific studies are also given. Project Gasbuggy is reviewed and various proposed projects are discussed. (J.R.D.)

29414 (UCRL-50812) GASBUGGY POSTSHOT HYDROLOGIC INVESTIGATIONS IN GB-3. Korver, J. A. (California Univ., Livermore. Lawrence Radiation Lab.). 9 Mar 1970. 18p. (PNE-G-62). Dep. CFSTI.

The Gasbuggy postshot well GB-3 was drilled, logged and cored to investigate the effects of the nuclear explosion on the Ojo Alamo aquifer. Postshot investigations in other wells (GB-ER, GB2-RS, and 10-36) indicated that hydraulic communication had been established between the aquifer and the gas reservoir. Hydrologic tests in GB-3 indicated that the permeability of the aquifer was increased by factors of 2 to 4 over preshot values at a radial distance of about 630 ft from the shot point. Investigations of the aquifer response to pressure changes in the reservoir, water levels in wells 10-36, GB-3 and the tubing annulus in GB-ER suggest that the main, if not only, point of hydraulic communication between aquifer and reservoir is through casing breaks in GB-ER. (auth)

29415 (USBM-1001) DYNAMIC AND STATIC RESPONSE OF THE GOVERNMENT OIL SHALE MINE AT RIFLE, COLORADO, TO THE RULISON EVENT. Merrill, Robert H.; Wisecarver, D. W.; Munson, Robert D.; Blake, Wilson (Bureau of Mines, Denver, Colo. Denver Mining Research Center). 2 Feb 1970. 39p. (PNE-R-28). Dep. CFSTI.

Results of an instrumented study to determine changes in roof or pillar displacement, the microseismic noise rate, and the roof and pillar vibrations resulting from the ground motion from the Rulison Event are presented. The Oil Shale Mine was operated by the U. S. Bureau of Mines between 1947 and 1956, and more than 90 percent of the mined area is over fifteen years old. The roof rock is known to deteriorate with time and, as a consequence, there has been a history of roof falls in roof areas where deterioration is greatest. There is no evidence of a major roof fall since March 1955, and the last known small fall was in January 1966. Because the mine roof is old and there is evidence of questionable stability, there was a reason to believe that the ground motion from the Rulison Event would create an unstable condition, especially if the motion were to cause resonant vibrations in roofs or pillars. The measurements were performed to detect both dynamic and static response to the motion. The analyses of the data leads to the conclusion that the mine responded to the ground motion generated by Rulison. The microseismic and vibration data show that the mine vibrated and generated microseisms; however, the response was back to normal within 8 to 10 seconds. The maximum acceleration, displacement, and particle velocity was 422×10^{-1} in/sec^2, 241×10^{-4} in, and 754×10^{-3} in/sec; these values were measured from a geophone located on a roof with a 60-foot span and in a crosscut. This roof geometry represents the condition for least roof support in the mine. Study results show that, if there was any damage created by the ground motion, the damage was too small to be seen or measured with these instruments. (auth)

Facilities and Equipment

Refer also to abstracts 29486, 29824, 29926, 30193, 30220, 30288, 30297, and 30656.

29416 (ANL-EBR-10) A VERTICAL SUBASSEMBLY ASSEMBLER-DISMANTLER FOR THE FUEL CYCLE FACILITY. EBR-II Project. Sales, W. L.; Mitchell, D. L.; White, J. R.; Simon, J. P. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Jan 1970. Contract W-31-109-eng-38. 23p. Dep. CFSTI.

A change in the program of Experimental Breeder Reactor II (EBR-II) from a power demonstration reactor to a fast-flux irradiation facility necessitated a corresponding change in the capabilities of the adjoining Fuel Cycle Facility (FCF) for handling irradiated subassemblies. A new vertical assembler-dismantler (VAD) capable of handling experimental subassemblies was designed, constructed, and installed in the FCF air cell to replace existing equipment for assembling and disassembling driver-fuel subassemblies. This machine was installed remotely with a minimum of interruption of normal cell activities. Performance of the new machine has met all design requirements adequately. (auth)

29417 (INR-1171) PLASMA FURNACE WITH LAMINAR PLASMA GENERATOR. Brzozowski, W.; Mikos, M. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 30p. (In Polish). Dep. CFSTI (U. S. Sales Only).

A description of the application of arc plasma furnaces for melting of various materials is given. The construction of the arc plasma furnace is described. Results of operating conditions of the arc plasma torch being a thermal source are cited. Some results obtained at the first series of melts, as well as some operating characteristics of the plasma torch and plasma furnace are given. (auth)

29418 (MTI-70-TR-33) A TWO PHASE FLOW ROTOR BEARING SYSTEM: EXECUTION OF AN EXTENDED (500 HOUR) TEST. Progress Report, January 1, 1969-March 31, 1970. Finkin, E. F.; Malanoski, S. (Mechanical Technology Inc., Latham, N. Y.). Apr 1970. Contract AT(30-1)-3839. 20p. (NYO-3839-9). Dep. CFSTI.

Activities in a program to develop design data and guidelines for the introduction of two-phase flow steam-lubricated bearings in turbomachines are summarized. Information is included on steam supply system development and instrumentation design. Information is also included on compressed air tests and 500 hour endurance tests. (J.R.D.)

29419 (SC-RR-68-223) ROLAMITE: GEOMETRY AND FORCE ANALYSIS. Cadman, Richard V. (Sandia Labs., Albuquerque, N. Mex.). Apr 1970. 293p. Dep. CFSTI.

The rolamite is a precision roller-band mechanism whose geometry may be tight, slightly loose (small deflection), or very loose (large deflection); the degree of looseness depends on the band tension. The rolamite band may be made to generate forces if its flexural rigidity is varied, or if it is precurved. An analysis of the rolamite geometry is presented here. The various clearances, total band length, and the position in the rolamite geometry of any band feature (e.g. cutout) can all be predicted in terms of band tension and other design parameters. The digital computer codes for this analysis are presented, and characteristics of typical rolamite geometries are plotted. The rolamite geometry analysis is shown to be the most powerful tool available for the determination of the band-generated force. Two more direct but less powerful techniques are presented, and results of the three methods are compared to experimentally determined force traces. Band-generated forces are discussed in detail. A dynamic analysis of the rolamite is included, with emphasis on inertial sensing applications. (auth)

29420 APPARATUS FOR MELTING URANIUM AND PLUTONIUM DIOXIDES. Schikarski, Lothar; Teiwes, Hans-Juergen (to Nukem Nuklear-Chemie und -Metallurgie Gesellschaft mbH). U. S. Patent 3,506,770. 14 Apr 1970. Priority date 29 Apr 1966, Germany.

A metal tank having a non-electrical ceramic lining is used instead of a graphite crucible to prevent short circuits between upper and lower electrodes when melting uranium and plutonium dioxides. (auth)

29421 PROCEEDINGS OF THE SIXTH SYMPOSIUM ON ELECTROEXPLOSIVE DEVICES, HELD IN SAN FRANCISCO, CALIF., JULY 8-10, 1969. Philadelphia; Franklin Institute Research Laboratories (1969). 586p. $25.00. (CONF-690720).

Fifty-two papers were presented at the symposium. A separate abstract was prepared for each of 3 papers. Papers for which no abstracts were prepared are concerned with electroexplosive devices and associated equipment not considered in the scope of NSA. (J.R.D.)

For abstracts of individual papers see: 29470, 29616, and 29915.

29422 THE ALPHA-GAMMA LEAD CELL SYSTEM IN THE POST-IRRADIATION LABORATORY OF METALLURGY DIVISION, AERE, HARWELL. Venables, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). 15p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).

See CONF-690331.

This laboratory is concerned mainly with detailed examination of specimens irradiated in materials testing reactors. A recent major development in the laboratory was the construction of an interconnected line of eleven alpha-gamma cells, whereby rapid transfer from process to process, together with large short term storage capacity and rapid waste disposal, has led to a large increase in the number of examinations carried out and to an improvement in the quality of these examinations. All permanent cells in the laboratory are constructed on the alpha-gamma principle, involving provision of a lead cell giving protection against β- and γ-radiation and an inner gas-tight box which contains the toxic materials, preventing their ingestion by personnel, and allowing the use of an inert atmosphere when required, as well as promoting general cleanliness in the laboratory by containment of all radioactive materials, and reducing or eliminating the need for regular decontamination of the areas around the cells. Details are given of the layout of typical cells, the interconnected cell line, the transfer tunnel, the transfer trolley, general use of lead shielding, etc. The advantages of lead brick shielding for this type of system are described in detail. (UK)

29423 200-CURIE ^{60}Co GAMMA-RAY IRRADIATION FACILITY FOR TEXTILE AND POLYMER STUDIES. Ikeda, Tetsuo (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ.; 48: 45-52(Jan 1970).

A 200-Curie cobalt-60 gamma irradiation facility for textile and polymer studies was installed at the Institute for Chemical Research, Kyoto University in 1969. This facility is composed of a source container and gamma irradiation system. As this facility is equivalent to a so-called gamma cell, it can be used in an experimental room without special buildings or construction for prevention of leakages. The leakage of gamma radiation of this facility is controlled by lead shielding below 0.5 mR/hr at the surface of the facility. (auth)

29424 COMPACT ^{60}Co IRRADIATION FACILITY. Katano, Rintaro (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ.; 48: 66-71(Jan 1970).

A compact gamma irradiation facility housing 2000 Ci ^{60}Co source and providing exposure rates up to 1.59×10^5 R/hr in the center of the sample chamber of 15 cm diameter by 30 cm height, is described. It consists of an annular source cage having twenty ^{60}Co pencils and a cylindrical drawer holding the movable sample chamber, surrounded by a main lead shield. The design is based on the fact that a stationary source requires less shielding and is easy to operate. Dose measurements were made using fluoroglass dosimeters. The isodose curves in the sample chamber are presented. (auth)

29425 EXHAUST AIR FILTERS FOR NUCLEAR PLANTS. Kerntechnik; 12: 175-7(Apr 1970). (In German and English).

Special casing designs which fulfill the particular requirements for tightness, safety in operation, and corrosion resistance to a high extent are typical features of air filters for nuclear plants. The casings made of impact-resistant plastic into which the special Grade S aerosol filters are cast air-tightly represent a novelty in this field of application. They offer numerous advantages compared to conventional designs. The possible combinations permit adaption to almost all local installation conditions. (auth)

29426 SURVEY OF RECENT PROBLEMS ON CONSTRUCTION, OPERATION, AND MAINTENANCE OF NUCLEAR POWER PLANTS. Yamasaki, Yasuo; Okamoto, Hideo (Central Research Inst. of Electric Power Industry, Tokyo). Denryoku Chuo Kenkyusho Gijutsu Kenkyusho Sogo Hokoku; No. 5, 75p(Aug 1969). (In Japanese).

Problems on the construction materials, design, manufacturing, operating characteristics, and safety of nuclear power plants, are discussed as far as they were investigated. Economic improvement of nuclear power plants needed a cut down on the allowance of construction and design, and might lead to a danger of fatal accidents. To keep nuclear power plants safe and reliable, reliable data for designing and manufacturing should be obtained first and a responsive action should be taken in case of accidents. (auth) (NSA of Japan)

Heat Transfer and Fluid Flow

Refer also to abstracts 30061 and 31058.

29427 (AAEC/E-202) SOME GEOMETRICAL PROPERTIES OF PACKINGS OF EQUAL SPHERES IN CYLINDRICAL VESSELS, PART III. BASIC MODEL AWAY FROM THE INFLUENCE OF WALL EFFECTS. Ridgway, N. W.; Tingate, G. A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan 1970. 15p. Dep. CFSTI (U. S. Sales Only).

An experimental study of the structure of random packings of equal spheres in cylindrical vessels, which indicated the existence of a continuous range, has been followed by an analytical investigation. A model was developed on the basis that random packings, excluding the influence of wall effects, can be formed by a process of expansion from the densest possible packing. Equations are derived connecting the mean void fraction, the mean number of points of contact, and other related properties. Both the three-dimensional and the two dimensional cases are considered, and are found to have similar features. The equations give values which are in good agreement with available experimental results and with values computed by other means. (auth) (Australia)

29428 (APED–5477) TWO-DIMENSIONAL DIFFUSER PERFORMANCE WITH SUBSONIC, TWO-PHASE, AIR–WATER FLOW. Hench, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.); Johnston, J. P. (Stanford Univ., Calif. Dept. of Mechanical Engineering). Jan 1968. 208p.

The pressure recovery performance of straight-wall, two-dimensional diffusers with air-water mixtures has been investigated, and their behavior as a function of gas volume flow ratio, β, and diffuser geometry, established within the limits of the experimental apparatus used. The ranges of parameters investigated were: gas volume flow ratio, β: 0 to 73%, area ratio, AR: 1.3 to 4, and diffuser length-to-throat width ratio, N/W_1: 3, 6, and 18. Diffusers with air-water mixtures have the same general characteristics as diffusers with single-phase fluids: for fixed length-to-width ratio diffusers, pressure recovery increases with increasing area ratio in the unstalled fluid dynamic flow regime, reaches a peak at the onset of stall and decreases again for larger area ratios in the stalled flow regimes. In stalled flow regimes, appreciable pressure recovery may be achieved in the constant area tailpipe downstream of the diffuser. The pressure recovery of diffusers with two-phase flow deteriorates with increasing air flow, especially after the two-phase flow regime changes from bubbly to churn-turbulent. The reduction in the diffuser performance with increasing air flow is very slight up to gas volume flow ratios of ~0.30, at which point the performance begins to fall off much more rapidly. Results of an analysis of two-phase ideal bubbly flow show good agreement with the trends in the bubbly flow regime and modification of this analysis for the churn-turbulent flow regime indicates that two-phase effects become very important at large values of gas volume flow ratio as indicated by the experimental results. (auth)

29429 (BNWL–1326) PROPERTIES OF AIR–STEAM MIXTURES CONTAINING SMALL AMOUNTS OF IODINE. Knudsen, J. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr 1970. Contract AT(45-1)-1830. 89p. Dep. CFSTI.

A tabulation of the physical properties of a saturated steam-air atmosphere is presented for a range of temperature (from 60 to 300°F) and pressure (from 14 to 70 psia). The physical properties tabulated include molecular weight, mole fraction, density, viscosity, thermal conductivity, heat-capacity, Prandtl number, diffusivity, and Schmidt number for steam, elemental iodine, and methyl iodide. The equations on which the tabulated data are based are referenced. In addition, constants needed for calculating terminal settling velocities of spherical drops are provided. The tabulated data are required in calculations for predicting heat and mass transfer in containment vessels of nuclear water reactors. (auth)

29430 (RD/B/N–1349) ANALYTICAL DESCRIPTION OF VAPOUR BUBBLE DYNAMICS IN WATER AND LIQUID SODIUM. Duffey, R. B. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Apr 1969. 29p. Dep. CFSTI (U. S. Sales Only).

The equations governing the dynamics of vapor bubbles in a liquid and their use in various models are examined. The limits of applicability of the equations and the restrictions implicit in the assumption of thermal equilibrium are discussed in detail. The published results of previous models are reviewed, and the use proposed of a general set of equations describing the dynamics of vapor bubbles. (auth)

29431 (RT/ING–(69)26) THEORY OF TWO-PHASE LIQUID-GAS FLOW. Basso, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 11 Sep 1969. 202p. (In Italian). Dep. CFSTI (U. S. Sales Only).

Results are presented showing that thermo-hydrodynamic instabilities, such as burn out, and the various two-phase flow patterns can be physically interpreted and analytically described on a thermodynamic basis, if the compressibility and the thermal expansion of the fluid are taken in due account. The present status of fluid mechanics is examined with the aim of evaluating the limits of the validity, in the case of adiabatic and two-phase flows. The general conditions for stability and instability of the flow are also discussed and new theories for friction and sonic flow in pipes are developed. An analysis of unsteady flows of compressible fluids (considered as fluiddynamic discontinuities of finite thickness) is carried out; a new theory of slip flow on microscopic basis is developed. Analytic expressions of the critical sonic velocities for a single-phase fluid are found, as function of the real out-flow conditions. (auth)

29432 (RT/ING–(69)31) LIQUID SUPERHEAT AND TWO-PHASE FLOW IN TRANSIENT EXPERIMENTS. Pinchera, G. C.; Tomassetti, G.; Farello, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 21 Oct 1969. 11p. (RVP-UTS–(69)1). Dep. CFSTI (U. S. Sales Only).

Experimental results on liquid sodium superheat under free convection conditions and on two-phase flow under low pressure water analogy conditions are presented. (auth)

29433 MEASUREMENT OF LOCAL VOIDAGE IN LIQUID/GAS TWO-PHASE FLOW SYSTEMS USING A UNIVERSAL PROBE. Miller, N. (Atomic Power Constructions Ltd., Heston, Eng.); Mitchie, R. E. J. Brit. Nucl. Energy Soc.; 9: 94-100(Apr 1970).

A probe system is described in which the change from liquid to vapor or gas at the tip is detected by the reflection of light from the tip. The operation of the system is independent of the electrical or thermal properties of the fluids employed. The probe was used for long periods to measure local void patterns in a large drum containing Freon and details of installation and operation are given. Comparison was made with the shutoff valve determination of average void fraction in 19 mm and 32 mm ID pipe at superficial liquid velocities up to 3 m/sec using water/air mixtures over a range of void fractions from 0.1 to 0.5. Good agreement was obtained at 1 m/sec in the 32 mm pipe. Probe readings at higher velocities and in the smaller pipe gave values lower than those determined from the shutoff technique. Mention is made of a probe designed to withstand high temperature water/steam environments. (auth) (UK)

29434 NONLINEARIZED TREATMENT OF AZIMUTHAL PERTURBATIONS IN THE CALCULATION OF FUEL ELEMENT TEMPERATURES. Wolf, L.; Johanssen, K. (Technische Univ., Berlin). Nucl. Eng. Design; 11: 16-26(1969). (In German).

The fuel element heat conduction problem in the r-φ plane is solved by a semianalytical method which accounts for simultaneous φ-variation of the heat source density in the fuel and the heat transfer coefficients at the fuel-cladding interface and the cladding surface. Numerical results obtained by the program FUELPERT show the different thermal behavior of UO_2 and UC fuel under various azimuthal perturbations. Discussions include a comparison of these results with linearized solutions of the problem. (auth)

29435 ENGINEERING ASPECTS, SOURCES, AND MAGNITUDE OF THERMAL POLLUTION. Krenkel, Peter A.; Parker, Frank L. (Vanderbilt Univ., Nashville). pp 10-52 of Biological Aspects of Thermal Pollution. /Krenkel, Peter A. (ed.). Nashville; Vanderbilt University Press (1969).

From National Symposium on Biological Aspects of Thermal Pollution, Portland, Oreg. See CONF-680638.

The engineering problems associated with the discharge of heated waters into our environment and reasonable methods for preventing these heated waters from adversely affecting receiving waters are discussed. It is concluded that achieving the ideal of returning cooling water temperatures to their original temperature before discharge into the environment is an excessively expensive procedure. Therefore the biologists should determine the recommended safe temperature levels, and then the engineers should examine methods for achieving these temperature levels. (L.C.L.)

29436 PROCEEDINGS OF THE 1970 HEAT TRANSFER AND FLUID MECHANICS INSTITUTE, MONTEREY, CALIFORNIA, JUNE 10–12, 1970. Sarpkaya, Turgut (ed.). Stanford, Calif.; Stanford University Press (1970). 379p. $15.00. (CONF-700606).

Twenty-three papers were presented at the conference. A separate abstract was prepared for each of three papers. Papers for which no abstracts were prepared are concerned with research on boundary layers, turbulent heat transfer, forced convection, hydrodynamic stability, instability in bubbling liquid columns, dropwise condensation, supersonic slot cooling, rheology, two-dimension flows, mass transport, expansion, slip flow, nozzle flow, ecological systems dynamics, transfer in optically thick gases, flow about pointed bodies, flow in shock tubes, Joulian heating, laminar flow, and viscous flow. (J.R.D.)

For abstracts of individual papers see: 29437–29439.

29437 EFFECT OF AN OSCILLATING PRESSURE ON NUCLEATE POOL BOILING. McCoy, K. E. (Marshall Space Flight Center, Huntsville, Ala.); Schoenhals, R. J.; Winter, E. R. F. pp 46-61 of Proceedings of the 1970 Heat Transfer and Fluid Mechanics Institute, Monterey, California, June 10–12, 1970. /Sarpkaya, Turgut (ed.). Stanford, Calif.; Stanford University Press (1970).

See CONF-700606.

Measurements of heat flux are presented for nucleate pool boiling in the presence of an oscillating pressure. These data are compared with the corresponding time averaged, quasi-steady heat fluxes predicted for both sinusoidal and square-wave pressure variations. During one test in which the heating surface temperature was maintained at a temperature corresponding to the saturation temperature at the maximum pressure, an 8-fold increase in heat flux was observed for a sinusoidally varying pressure. The quasi-steady analysis predicts only a $2\frac{1}{2}$-fold increase for these operating conditions. The additional improvement in heat transfer above that predicted for quasi-steady conditions can be attributed to dynamic effects. These effects are interpreted in the light of the naturally occurring bubble release frequencies. (auth)

29438 HEAT TRANSFER IN OPEN-CIRCUIT ALIGNED-FIELD MAGNETOHYDRODYNAMIC FLOW PAST A FLAT PLATE. Ky, K. C.; Tan, W. W. (Cooper Union for the Advancement of Science and Art, New York). pp 339-53 of Proceedings of the 1970 Heat Transfer and Fluid Mechanics Institute, Monterey, California, June 10–12, 1970. /Sarpkaya, Turgut (ed.). Stanford, Calif.; Stanford University Press (1970).

See CONF-700606.

The steady-state heat transfer phenomena in a laminar flow of an incompressible, viscous, electrically conducting fluid of constant properties past a semi-infinite flat plate are investigated. The ambient magnetic field is coincident with the ambient velocity which is parallel to the plane of the plate. Attention is focused on a particular flow with an open-circuit condition wherein electric currents circulating within the boundary layer are conserved. Several techniques are used to treat the problem. One successful technique is the method of parametric differentiation which not only transforms the nonlinear flow problem into a linear one, but also facilitates numerical integration of the problem; another is the Karman integral technique employed to study the effect of applied magnetic field on the development of viscous, magnetic, and thermal boundary-layer thickness. Contrary to the Greenspan-Carrier short-circuit problem, the skin friction factor and current density at the plate surface are finite and non-zero as β approaches unity. Results are also presented for the velocity, magnetic field, and temperature distributions; the development of viscous, magnetic, and thermal boundary-layer thicknesses; and the heat transfer characteristics for both a thermally-insulated and a uniform-temperature plate. (auth)

29439 HEAT TRANSFER FROM SURFACE ROUGHENED BY THREAD-TYPE RIBS AT HIGH TEMPERATURES. Dalle Donne, M.; Meerwald, E. (Nuclear Research Center, Karlsruhe, Ger.). pp 354-70 of Proceedings of the 1970 Heat Transfer and Fluid Mechanics Institute, Monterey, California, June 10–12, 1970. /Sarpkaya, Turgut (ed.). Stanford, Calif.; Stanford University Press (1970).

See CONF-700606.

The experiments have been performed with 15 different electrically heated rough rods at surface temperatures up to 1200°C, contained in concentric smooth tubes. The experimentally obtained 15 different velocity parameters $R(h^+)$, relative to the rough surface only, are a function of the product pitch/height times pitch/width of the threads only, for two annuli with different r_2/r_1 ratio. By means of the factor $R(h^+)$ it is possible to obtain the friction factor for the relative roughness in any geometrical arrangement, provided the velocity law of the wall of Nikuradse for sand-roughness is still valid. The heat transfer coefficients have been correlated with the parameter $G(h^+) = R(h^+) + [(f_1/2\ St_1) - 1/\sqrt{(f_1/2)}]$ introduced by Dipprey and Sabersky for sand roughness, by the equation: $G(h^+) = 5.8(h^+)^{0.2}\ Pr^{.66}(T_{w1}/T_E)^{0.2}$. (auth)

Isotope Technology

Refer also to abstracts 29423, 29424, 29446, 29545, and 31120.

29440 (CEA-N-1284) BOREAL: A PILE FOR TESTING BORON CONTENT OF ALUMINUM–BORON ALLOY SAMPLES. Carre, Jean-Claude; Letour, Christian (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar 1970. 28p. (In French). Dep. CFSTI (U. S. Sales Only).

The basis and the description of the measurement assembly BOREAL are given and the first results are reported. BOREAL is a small graphite array containing a neutron source. It is intended for testing the boron or absorber content of small slabs, for instance aluminum–boron alloy slabs. With appropriate reference samples the absolute boron or absorber content can be determined. In the case of testing made for instance on samples containing 400 ppM of boron enriched at 90 per cent in ^{10}B, corresponding to 14 mg of boron, the statistical accuracy of a single measurement of 2000 sec. is about 8 ppM (2 per cent). (auth) (France)

29441 (DP-1226) ^{60}Co POWER AND HEAT SOURCES. Quarterly Progress Report, October–December 1969. Angerman, C. L.; Ross, C. P. (comps.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar 1970. Contract AT(07-2)-1. 23p. Dep. CFSTI.

High reaction rates between cobalt metal and the capsule walls observed in two capsules containing radioactive cobalt metal were caused by NaOH residue on the cobalt wafers. Heating for 10,000 hr at 1000°C was completed on radioactive capsules of Inconel 600, Hastelloy C, and Hastelloy X. Minor amounts of ^{60}Co were released when a capsule with an intentional defect was heated for 5000 hr at 1000°C. Fabrication processes were established for wafers of CoO, $Co_{0.5}Mg_{0.5}O$, and $CoAl_2O_4$, and irradiation of 120 wafers of each compound was begun. High activity cobalt metal is being produced for experimental purposes and the AEC's ^{60}Co loan program. (auth)

29442 (N-70-20372) ACTIVITIES OF THE RTG RADIATION TEST LABORATORY. Progress Report, July 1–December 31, 1969. Campbell, R. W.; Dore, M. A.; Reier, M. (Jet Propulsion Lab., Pasadena, Calif.). Jan 1970. Contract NAS7-100. 26p. (JPL-701-39; EM-342-101). CFSTI.

The safety analysis report for the RTG radiation test lab receipt of SNAP-19 or 27 fuel capsule assemblies was written and has received JPL approval. The gamma-ray spectrum from a SNAP-27 fuel capsule assembly was measured with both a calibrated Ge(Li) solid state spectrometer and with a 3 in. × 3 in. NaI(Tl) scintillation spectrometer. Data analysis was completed for the gamma-ray spectrum measurements of a SNAP-15A heat source using a Ge(Li) spectrometer. This has lead to a new technique for determining ^{238}Pu impurity concentrations. (auth) (Star)

29443 (ORNL-TM-2985) ISOTOPE PROGRAM (5000) PROGRESS REPORT FOR QUARTER ENDING MARCH 31, 1970. Gillette, J. H. (Oak Ridge National Lab., Tenn.). May 1970. Contract W-7405-eng-26. 18p. Dep. CFSTI.

Research progress is reported on target fabrication and development, stable isotope separations, radioisotope separations, sector isotope separator experiments, processing chemistry, and isotope preparation and sales. (J.R.D.)

29444 (SC-RR-70-134) SCALING LAWS FOR FUEL CAPSULES SUBJECTED TO BLAST, IMPACT, AND THERMAL LOADING. Duffey, T. A. (Sandia Labs., Albuquerque, N. Mex.). May 1970. 45p. Dep. CFSTI.

Scaling laws are reviewed and developed for the large deflection transient response of structures governed by nonlinear constitutive relationships. The results are interpreted in terms of the response of fuel capsules to blast, fragment impact, earth impact, and thermal loading. It is shown that generally fuel capsules can be simulated during testing by small scale capsule models of identical materials as the prototypes, and in certain instances by models constructed of dissimilar materials. Problem areas for both testing techniques are isolated. The scaling laws are shown to be supported by an independently developed analysis of a blast loaded structure undergoing elastic-plastic behavior. (auth)

29445 STUDY OF THE ANGULAR DISTRIBUTION AND ENERGIES OF ALPHA PARTICLES EMITTED BY ^{241}Am SOURCES. Yeates, D.; Harris, S.; Doust, C. (Univ. of Surrey, Guilford, Eng.). Nucl. Instrum. Methods; 80: 320-4(1970).

The angular distribution and energies of alpha particles emitted from both a vacuum sublimed and a silver-palladium coated ^{241}Am source were examined with a low geometry spectrometer using a surface barrier detector. Computer programmes were developed to allow integration of data over 2π sterad. Data from the above two sources are presented. (auth)

29446 ISOTOPES AND RADIATION TECHNOLOGY. VOLUME 7, NUMBER 4. Baker, P. S.; Lafferty, Robert H. Jr.; Gerrard, Martha; Greene, R. E.; McKinney, F. E.; Miller, F. J. (eds.). One of Four Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn.; Oak Ridge National Laboratory (Summer 1970). 118p. GPO $0.70.

Separate abstracts were prepared for 16 sections of this review. (H.L.W.)

For abstracts of individual sections see: 29372, 29447–29460, and 29704.

29447 AD HOC PANEL REPORT ON THE NATIONAL USES AND NEEDS FOR SEPARATED STABLE ISOTOPES. Isotop. Radiat. Technol.; 7: 363-77(Summer 1970).

The role that the U. S. Atomic Energy Commission's stable-isotope separations program has had in advancing nuclear sciences is discussed and the program in terms of present and future needs is reviewed. Past, present, and future uses of separated stable isotopes in basic and applied nuclear physics, nonnuclear physics, chemistry, earth sciences, and biology and medicine are discussed. The acceptance and continuance of the program as a national resource of great value to the United States is recommended. (auth)

29448 INDUSTRIAL MEASUREMENT CONSIDERATIONS FOR USE OF LOW-ENERGY PHOTONS FROM NUCLEAR SOURCES. Evans, Howard J. (Industrial Nucleonics Corp., Columbus, Ohio). Isotop. Radiat. Technol.; 7: 381-95(Summer 1970).

The applications of low-energy photons from radioisotopes for industrial measurement and control are reviewed. The choice of source, the interaction between the photons and the object measured, and the means of radiation detection are considered. Competing alternative techniques are compared. The sum total of effects and optimum choice of equipment are related as they pertain to the desired measurement. (auth)

29449 OLD BREMSSTRAHLUNG UNIVERSITY: TWO DECADES OF TRAINING IN THE NUCLEAR SCIENCES. Yegge, John F.; Smithwick, Grover (Oak Ridge Associated Universities, Tenn.). Isotop. Radiat. Technol.; 7: 402-7(Summer 1970).

Since its inception in 1948, Old Bremsstrahlung University (Special Training Division, Oak Ridge Associated Universities) has fulfilled a unique role in the area of training and education in the atomic and nuclear sciences. Over the years, expansion of the activities at the Special Training Division of Oak Ridge Associated Universities has paralleled the growth of the nuclear sciences in the fields of education, medicine, research, and technology, resulting in several particularly effective programs. (auth)

29450 RADIOACTIVE TRACER TECHNIQUE FOR LABORATORY CORROSION STUDIES. Close, Harry J.; Hines, D. B. (Monsanto Co., St. Louis). Isotop. Radiat. Technol.; 7: 407-10 (Summer 1970).

A radioactive tracer method for determining the corrosion rates of mild steel and 316 stainless steel in sulfuric acid at room temperature was developed. Irradiated coupons of the metal under test were exposed to sulfuric acid, which was circulated to a flow cell in the well of a scintillation counter. The corrosion rates were determined by comparing the counting rates with those from known weights of irradiated comparison standards. (auth)

29451 USE OF ^{252}Cf FOR MINERAL EXPLORATION: COMPARISON WITH ACCELERATORS FOR IN SITU NEUTRON ACTIVATION OF SILVER. Senftle, F. E.; Philbin, P. W.; Sarigianis, P. (Geological Survey, Washington, D. C.). Isotop. Radiat. Technol.; 7: 411-18(Summer 1970).

Tests were made on the use of ^{252}Cf and accelerators as neutron sources for in situ neutron activation of silver, with gamma-spectrometer detection of the activated silver. Comparison of the results indicated some advantages of ^{252}Cf. (auth)

29452 APPLICATIONS AND POTENTIAL APPLICATIONS OF RADIOISOTOPES TO MELT-SHOP STEELMAKING OPERATIONS. Tucker, W. B. (Republic Steel Corp., Cleveland). Isotop. Radiat. Technol.; 7: 419-33(Summer 1970).

After providing background material to explain the various needs that radioisotopes can help meet in modern steelmaking melt-shop operation, current uses are reviewed and some possible future uses of radioisotopes suggested. Present uses include analysis of raw materials; identification of alloy elements; level gages; refractory wear gages; investigations of steelmaking kinetics; tracing sources of foreign inclusions, measurement of currents in the molten metal; and quick chemical analyses. Applications to casting include determination of solidification rate and location of liquid center in strand castings. (auth)

29453 INSPECTION OF HAND-GRENADE FUSES WITH A RADIOACTIVE ISOTOPE. Isotop. Radiat. Technol.; 7: 434-6 (Summer 1970).

A method for inspecting the delay-column height (M200 series) in hand-grenade fuses was developed in which a tracer quantity of a radioactive element is incorporated in the delay composition. The gamma radiation from each fuse is measured to give data from which the total delay-charge weight is calculated. Tests on the method with plant-size batches of delay composition indicated that an inspection rate of two units per second can be achieved without exceeding permissible external radiation dose levels. (auth)

29454 USE OF RADIOISOTOPES IN DETECTOR CALIBRATIONS. McCrary, J. H. (Edgerton, Germeshausen, and Grier, Inc., Las Vegas, Nev.). Isotop. Radiat. Technol.; 7: 436-9(Summer 1970).

A means for measuring detector sensitivities to monoenergetic electromagnetic radiations is described. The accuracy of the results should be approximately ±10%, which is comparable with measurements now being made with x-ray machine sources. (auth)

29455 GAMMA-RAY WELD-INSPECTION SYSTEM. Payne, D. M. (Atomics International, Canoga Park, Calif.). Isotop. Radiat. Technol.; 7: 440-2(Summer 1970).

A system containing three ^{170}Tm gamma radiation sources was used to inspect an opposed-arc weld for weld nugget penetration in an Al–Cu alloy. The system compared the difference between gamma-radiation attenuation through the center of the weld, where attenuation was greater owing to concentration of copper, with that through the sides. The amount of copper concentration increased with weld-nugget overlap. (auth)

29456 SNAP-27 ON THE MOON. Prosser, D. L. (Mound Lab., Miamisburg, Ohio). Isotop. Radiat. Technol.; 7: 443-7 (Summer 1970). (MLM–1698).

A SNAP-27 thermoelectric generator left on the moon by the Apollo 12 astronauts was designed to provide electrical power for five experiments on the lunar surface. The source is fueled with 3735 g (8.36 lb) of ^{238}Pu dioxide microspheres, which produce 63 W(e) [1480 W(th)] of power. The sources were designed, fabricated, encapsulated, and extensively tested to ensure the integrity of the system prior to flight authorization. (auth)

29457 RADIOISOTOPIC HEAT SOURCE ON THE MOON. Kelly, D. P.; Avona, V. L. (Mound Lab., Miamisburg, Ohio). Isotop. Radiat. Technol.; 7: 448-9(Summer 1970). (MLM–1637).

Two radioisotope-fueled heaters were left on the moon by the Apollo 11 astronauts for protection of seismic instrumentation. Each heater was fueled with 37.6 g of $^{238}PuO_2$ microspheres, which produce 15 W(t). The sources were designed, fabricated, encapsulated, and extensively tested to ensure integrity of the system prior to flight authorization. (auth)

29458 ISOTOPIC ENERGY SYSTEMS FOR UNDERSEAS APPLICATION. Isotop. Radiat. Technol.; 7: 449-51(Summer 1970).

In April 1967 the Committee on Undersea Warfare and the Office of Naval Research sponsored a Conference on Energy Sources of Extended Endurance in the 1 to 100 kW Range for Naval Applications. A subsequently appointed Panel on Energy Sources reviewed all types of energy systems. Their recommendations with regard to the development of isotope-fueled systems for undersea use are presented. (L.C.L.)

29459 RADIOISOTOPE PROGRAM IN INDIA. Iya, V. K.; Deshpande, R. G. (Bhabha Atomic Research Centre, Bombay). Isotop. Radiat. Technol.; 7: 452-7(Summer 1970).

The radioisotope program in India is described in terms of the production facilities at Trombay, the quantity of specific isotopes currently being produced, and the growth and variety of isotope uses in India. (L.C.L.)

29460 SURVEY OF RADIOISOTOPE APPLICATIONS IN LATIN AMERICA. Baro, G. B.; Flegenheimer, J. G. (Comision Nacional de Energia Atomica, Buenos Aires). Isotop. Radiat. Technol.; 7: 465-8(Summer 1970).

Radioisotope uses in Latin America are summarized with special emphasis on uses in Argentina. (L.C.L.)

29461 USE OF RADIOISOTOPES IN INDUSTRIAL PLANTS UNDER ARTICLE 55 OF D.P.R. 185 OF 13th FEBRUARY 1964: OBSERVATIONS IN THE MATTER OF RELEVANT AUTHORIZING LEGISLATION. Nocera, F. (CNEN, Rome). G. Fis. Sanit. Prot. Radiaz.; 13: 154-9(Apr–Jun 1969). (In Italian). (RT/PROT–(69)41).

The legislation contained in the law under Article 55 of D.P.R. 185 of Feb. 13, 1964 is considered by critically interpreting the requirements for the industrial use of radioisotopes. The implications of legislative and technical aspects are evaluated and changes are suggested for the present legislation. (J.C.W.)

29462 VARIOUS APPLICATIONS OF RADIOACTIVE ISOTOPES IN HYDROLOGY. Rezio, Amelia (Lab. of Nuclear Physics and Engineering, Sacavem, Portugal). Rev. Port. Quim. (Lisbon); 11: Nos. 1-4, 142-52(1969). (In Portuguese).

The use of radioisotopes in hydrology are reviewed and some hydrological problems are presented. Three examples illustrate those applications. (auth)

29463 RADIOISOTOPE ENERGY FOR POLAR STATIONS. Polarforschung; 37: 169-71(1967). (In German).

The effectiveness and the costs of various radioisotopes, in particular ^{60}Co and ^{140}Ce, are considered for use as energy sources for 5 to 10 kW generators to be installed at polar weather stations. Comparisons with the costs for using gasoline and oil are made. (Meteorol. Geoastrophys. Abstr.)

29464 AERODYNAMIC SEPARATION EFFECT ON GAS AND ISOTOPE MIXTURES INDUCED BY INVASION OF THE FREE JET SHOCK WAVE STRUCTURE. Campargue, Roger (Centre d'Etudes Nucleaires, Saclay, France). J. Chem. Phys.; 52: 1795-1802(15 Feb 1970).

The shock wave system of the underexpanded free jet, in a region where the pressure is in the range of 10^{-2} up to 1 torr, is partly invaded by background molecules, these latter being pumped and carried by the supersonic flow. When a gas mixture is introduced into the nozzle chamber and outside the shock barrel, this aspiration acts very selectively on the light molecules, and a mixture enriched in lighter species is attainable by skimming the free jet. This new aerodynamic separation effect, which is applicable to isotopic mixtures, is very strong in comparison to the efficiency of an elementary gaseous diffusion membrane. (auth)

Materials Testing

Refer also to abstracts 29444, 29453, 29486, 29935, 29943, 29949, 29995, 30031, and 30050.

29465 (ANL-7630) ANALYTICAL MODELS FOR THE PREDICTION OF CREEP DEFORMATIONS IN HOLLOW, FINITE, RIGHT-CIRCULAR CYLINDERS. Widera, O. E.; Weeks, R. W. (Argonne National Lab., Ill.). Jan 1970. Contract W-31-109-eng-38. 25p. Dep. CFSTI.

The analytical prediction of primary and secondary creep deformations in hollow, finite, right-circular cylinders loaded by axial tension or by compression, and subjected to internal and external pressure, and to arbitrary temperature gradients is discussed. (auth)

29466 (BMI-1883) REVIEW OF THROUGH-WALL CRITICAL CRACK FORMULATIONS FOR PIPING AND CYLINDRICAL VESSELS. Eiber, Robert J.; Maxey, Willard A.; Duffy, Arthur R.; Atterbury, Thomas J. (Battelle Memorial Inst., Columbus, Ohio). May 1970. Contract W-7405-eng-92. 29p. Dep. CFSTI.

Six formulations for the prediction of axial through-wall critical crack lengths are presented. The formulations are evaluated by computing toughness values for the experimental data obtained in the AEC Ductile Pipe Rupture Study. It is concluded that the tough ductile materials appear to follow the behavior predicted by the flow stress equation. The flow stress relationship is the simplest of those examined and yet exhibits the least variation in toughness values. The other equations reviewed also provide reasonably accurate results but because of their complexity or empirical nature do not appear to be as desirable as the flow stress equation for the high-toughness material examined. (auth)

29467 (BNWL-1355) AN EDDY CURRENT TUBE TESTING TECHNIQUE USING A HYBRID COIL CONFIGURATION WITH SEQUENTIAL SAMPLING. Ryden, J. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. Contract AT-(45-1)-1830. 15p. Dep. CFSTI.

A new eddy current tube testing technique has been developed. This technique has increased resolution and sensitivity to defects and a reduction of nonpertinent tubing variations as compared to the encircling coil technique. This is accomplished with no loss of inspection rate. The new technique utilizes a hybrid coil configuration consisting of both encircling coils and probe coils. The encircling coils are used as the drivers. A plurality of probe coils, mounted between the encircling coils around the coil form circumference, serve as the pickups. These are sequentially sampled at a rapid rate; thus, a 100% inspection of the tube is performed by only translating the tube through the coil form. (auth)

29468 (BNWL-1359) THE NONDESTRUCTIVE EXAMINATION OF G AND H LOTS FFTF FUEL CLADDING. Ryden, J. Jr.; Perrizo, E. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. Contract AT(45-1)-1830. 21p. Dep. CFSTI.

An inspection for defects, using ultrasonic techniques, has been performed on 2744 ft of small diameter stainless steel tubing (G and H Lots). The intended use for this tubing was as reactor fuel cladding in fuel performance studies for the Fast Flux Test Facility (FFTF). The ultrasonic pulse-echo inspection mode was used to detect and reject defects equal to or greater than 8% of the wall thickness in depth. Statistical control techniques were used to maintain the precision of the tester to a known value. This provided a test of high reliability and a greater assurance that defects of rejectable size were actually rejected. Although the two lots had the same metallurgical composition, they were fabricated differently. The H Lot tubes were fabricated in a conventional manner. The G Lot received extra treatment and care in the fabrication in an attempt to reduce the number of rejectable defects. The test results verified that G Lot did have fewer defects; i.e., 8% for G Lot versus 15% for H Lot. (auth)

29469 (CONF-690339) 5th INTERNATIONAL SYMPOSIUM ON INDUSTRIAL RADIOGRAPHY, 27-28 MARCH 1969. (Gevaert-Agfa N. V., Antwerp (Belgium)). 130p. (In several languages).

Papers are included on use of the modulation transfer function to examine industrial radiographic techniques, use of radiography in materials testing, radiographic film interpretation, nondestructive testing of fusion welds, detail perceptibility in industrial radiography, significance of luminous density in radiographs, production and interpretation of radiographs, radiography of pressure vessels and power plant piping, automated radiography, relations of image quality with detection of material flaws, and radiographic inspection using x-rays and gamma radiation. (J.R.D.)

29470 NONDESTRUCTIVE TESTING OF APOLLO CSM SPACECRAFT ORDNANCE DEVICES BY NEUTRON RADIOGRAPHY. Knight, W. H. (North American Rockwell Corp., Downey, Calif.); Hitchens, A. L.; Ewbank, N. M.; Gigas, G. pp 2.11.1-16 of Proceedings of the Sixth Symposium on Electroexplosive Devices, Held in San Francisco, Calif., July 8-10, 1969. Philadelphia; Franklin Inst. Research Labs. (1969). See CONF-690720.

Nondestructive testing of Apollo CSM (Command and Service Module) spacecraft ordnance devices has been accomplished by indirect and direct neutron radiography using a 1 megawatt swimming pool reactor source. These examinations have shown discrepant loading, internal debris and contamination. A process specification has been developed for neutron radiographic testing and a certification program for n-radiographic film readers has been established. This method has proven to be a good technique for analysis and offers promise for future development of new electroexplosive devices. (auth)

29471 ROLE OF REACTORS AND ACCELERATORS IN TESTING REACTOR MATERIALS IN THE UK. Pugh, S. F. (Atomic Energy Research Establishment, Harwell, Eng.). J. Brit. Nucl. Energy Soc.; 9: 81-4(Apr 1970).

Irradiation testing can be done in civil power reactors, prototype reactors, research reactors, or by using beams of charged particles from accelerators. The particular types of radiation experiment most suitable for each type of radiation facility are discussed. The main types of radiation effect which have major technological significance are briefly described and are related to experiments in the different types of irradiation facilities. The main technical requirements for experiments are discussed in detail. (auth) (UK)

29472 STUDIES ON THE USE OF ELECTRORADIOGRAPHIC TECHNIQUE IN NONDESTRUCTIVE X-RAY AND GAMMA-RAY MATERIALS TESTING. Huenicke, U.-D.; Heinz, H.-E. (Technische Hochschule, Magdeburg, Ger.). Isotopenpraxis; 6: 41-8(Feb 1970). (In German).

Electroradiographic test plates have been manufactured and compared with x-ray films with respect to their imaging properties. The results compared are with international state in electroradiography. (auth)

29473 RADIOMETRIC INSPECTION OF COAL BLOCKS. Domanus, J.; Godlewski, Z.; Kowalska, Z. (Institut fuer Elektrotechnik, Warsaw). Isotopenpraxis; 6: 60-3(Feb 1970). (In German).

Although radiographic technique of materials testing has the best discernability of defects, it doubtless cannot be applied for serial inspections of ceramic elements, coal blocks, or other similar nonmetallic materials of high thickness. In such cases the radiometric technique is being used, that is more rapid and cheaper than radiography and, moreover, enables automatization.

After good results were obtained during inspection of ceramic elements 400 mm in thickness, coal blocks of the same thickness have been tested according to a similar technique. These blocks have been studied at first by radiography and then by radiometry. (auth)

29474 FINITE ELEMENT INCREMENTAL ELASTIC–PLASTIC ANALYSIS OF PRESSURE VESSELS. Zudans, Zenons (Franklin Inst. Research Labs., Philadelphia). J. Eng. Ind.; 92: 293-302 (May 1970).

An analysis method is described which is designed to handle the general case of an axisymmetric shell under axisymmetric loadings. Incremental approach is used under the consideration of the first order approximation in determining the tangent stiffness characteristics of the finite element. Effects of strain hardening, both isotropic and kinematic, are included. In order to account for instability and large accumulated deformations during the loading of the structure, the effect of the initial stress on the element stiffness is included. Incremental principle of virtual work is used to derive the working equations. A computer program is designed and utilized to generate the design charts for formed heads of pressure vessels of various configurations. A detailed description of the numerical techniques used to apply the theory is included along with sample problem solutions. (auth)

29475 TRANSIENT THERMAL STRESSES ON A FINITE DISK DUE TO A CONTINUOUS POINT HEAT SOURCE. Hsu, T. R. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). J. Eng. Ind.; 92: 357-65(May 1970).

Solutions are presented for transient temperature distribution and associated quasi-static thermal stresses and deformations which arise in a thin circular disk of finite radius subjected to a continuous point heat source acting on its periphery. It is shown that the solutions of this type of problem may be obtained by integrating the time variable of the corresponding solutions in the case of an instantaneous point heat source. The solutions are given in the form of double infinite series and graphical representations of the solutions in dimensionless terms are included. Reference is made to methods of applying the solutions to shapes other than disks. The solutions are pertinent to problems which occur in welding engineering and modern nuclear technology. (auth)

Protective Structures

Refer also to abstract 30374.

Radioactive Material Handling

Refer also to abstracts 29422, 31029, and 31031.

29476 (BNWL–1386) STATISTICAL TECHNIQUES FOR ENHANCING THE ROLE OF MATERIAL BALANCE ACCOUNTING IN SAFEGUARDS. Stewart, K. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. Contract AT(45-1)-1830. 63p. Dep. CFSTI.

The use of a statistical model to assist in making certain basic determinations (such as whether an apparent loss occurred as a single incident or as several incidents over a period of time) is examined. From such determinations the proper course of action is determined. The importance of highly accurate measurements and the proper application of as much pertinent data as can be used to obtain meaningful results are stressed. (auth)

29477 (DUN–1100(Rev.1)) CONTROL OF FISSILE RADIOACTIVE MATERIAL. (Douglas United Nuclear, Inc., Richland, Wash.). Jun 1969. 14p. Dep. CFSTI.

Instructions for control of fissile radioactive materials within the Douglas United Nuclear Inc., are presented. Definitions and references are included along with information on procedures for shipping, receiving, posting and labeling, and transferring fissile radioactive materials. (J.R.D.)

29478 (DUN–2894(Rev.1)) TECHNICAL BASES FOR EX-REACTOR CRITICALITY SAFETY SPECIFICATIONS AND PROCESS STANDARDS. Chitwood, R. A. (Douglas United Nuclear, Inc., Richland, Wash.). 5 Sep 1969. Contract AT(45-1)-1857. 26p. Dep. CFSTI.

The presence of fissile material outside of a nuclear reactor requires controls to reduce the probability that a quantity sufficient to sustain a nuclear chain reaction could be assembled. The philosophy and criteria utilized in establishing ex-reactor criticality control limits and procedures for the N Reactor and the fuel fabricating facilities are given, along with a summary of criticality parameters and safe limits for N Reactor and single pass reactor fuel geometries in a light water moderator. Data on critical parameters and safe limits for current single pass and dual purpose reactor fuel designs are appended. (19 references) (J.C.W.)

29479 (DUN–5750) NUCLEAR SAFETY SPECIFICATIONS: FUELS. (Douglas United Nuclear, Inc., Richland, Wash.). 12 Dec 1969. 119p. Dep. CFSTI.

Nuclear safety specifications including requirements concerning dimensions and enrichment, processing, handling and storage, and shipping of enriched U are summarized. Specifications are also included on lower enrichment materials and other fissile materials. (J.R.D.)

29480 (DUN-M–4(Rev.2)) NUCLEAR MATERIALS MANAGEMENT PROCEDURES MANUAL. Prudich, Tony; Doriss, Clinton P.; Handshuh, Jerry W. (Douglas United Nuclear, Inc., Richland, Wash.). 17 Nov 1969. 46p. Dep. CFSTI.

Procedures used by nuclear materials management and custodians of SS materials within the Douglas United Nuclear Inc., for receipt, control, and shipment of these materials are described. (J.R.D.)

29481 (KURRI-TR–68) SYMPOSIUM ON THE FUTURE OF USED FUEL TRANSPORT AND THE PROBLEMS, KUMATORI, OSAKA, 11 MARCH 1969. Katsurayama, Kosuke; Tsujimoto, Tadashi (Kyoto Univ. (Japan). Research Reactor Inst.). 47p. (In Japanese). (CONF-690340).

The future of transport of used fuels and the associated problems, especially in large-scale commercial atomic power stations, is examined. The following reports, and also the panel discussion, given at the Symposium, are given: present status in overseas countries, and the international problems; transport of used fuels in Japan; reprocessing of used fuels in Japan; legal procedures concerning the transport of used fuels in Japan; research, development, and standards on transport containers; the future of used fuel transport in Japan; and insurance-against-loss in transport of used fuels. (NSA of Japan)

29482 (LA–4368) NUCLEAR SAFEGUARDS RESEARCH AND DEVELOPMENT. Program Status Report, October–December 1969. Keepin, G. Robert (ed.) (Los Alamos Scientific Lab., N. Mex.). 4 Feb 1970. Contract W-7405-eng-36. 23p. Dep. CFSTI.

Methods described for the nondestructive assay of fissionable materials include delayed-neutron assay of fissionable material in 1-gallon recovery cans, delayed neutron assay of safeguards inventory samples, californja-252 source for neutron interrogation and assay, and delayed neutron assay of Rover scrap material. Passive assay techniques and applications are discussed. The parameters of the delayed neutron yield-vs-energy measurements and delayed neutron abundances and half-lives for 14.7-MeV fission are given. Delayed-neutron detector optimization, add-a-gram apparatus for scrap barrel assay, and the development of electronics and instrumentation are also described. Construction progress and uses of the mobile nondestructive assay laboratory are reported. Development of the Accelerator I Neutron Generator, Van de Graaff Accelerator Facility, and the Cockcroit-Walton Accelerator Facility for use in nuclear safeguards research is discussed. (J.C.W.)

29483 (SZS–2/70) ECONOMY OF THE DISPOSAL OF RADIOACTIVE WASTES FROM NUCLEAR POWER PLANTS AND THE REPROCESSING OF IRRADIATED NUCLEAR FUELS. Fischer, W.; Buhl, G. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Jan 1970. 24p. (In German). Dep. CFSTI (U. S. Sales Only).

The portion of current generating costs caused by the disposal of radioactive wastes from nuclear power plants and fuel reprocessing installations as well as the most important factors influencing the system of waste disposal are outlined. Different variants are formulated combining the quantity of wastes of a proposed nuclear power application with the suitable technologies of the treatment and disposal of radioactive wastes. The boundary conditions, the evaluation criteria, and the result of the evaluation of two variants with assumed investment and operation costs are presented. (auth)

29484 (SZS–4/70) INTEGRITY OF TYPE A AND B PACKAGING FOR SHIPMENT OF RADIOACTIVE MATERIALS. Richter, D.; Birkigt, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Mar 1970. 22p. (In German). Dep. CFSTI (U. S. Sales Only).

On the basis of an analysis of the requirements on the integrity of packages for the shipment of radioactive materials currently

in use, the relationships are outlined which allow derivation of the necessary radiological integrity (activity leakage rates) or engineering integrity (gas leakage rates) from radiation protection parameters. Some representative examples are calculated of types A and B packages for radioactive materials of medium activity. Proposals are made for more precise regulations on integrity. (tr-auth)

29485 (UCRL-50828) RAVE: A COMPUTER CODE FOR ANALYZING THE NON-STEADY INCOMPRESSIBLE FLOW OF A FLUID INTO OR OUT OF A NUCLEAR CHIMNEY. Korver, John A. (California Univ., Livermore. Lawrence Radiation Lab.). 25 Feb 1970. 35p. Dep. CFSTI.

The RAVE code is a one-dimensional numerical model which simulates the time-dependent growth of a ground water mound resulting from the injection of fluid into a well. The code uses finite difference approximations to the differential equations describing the flow characteristics of a ground water mound with a free surface. RAVE was developed primarily to examine the usefulness of nuclear chimneys as waste disposal facilities in environments where a free (water table) surface would develop. The code organization, the computational scheme, and the forms of the input and output are described. An example problem is given, showing how to set up the input. Examples of the input and output formats, the Fortran program and the code flow diagrams are included. (auth)

29486 LEAD SHIELDING AND NUCLEAR SAFETY CONFERENCE, 1969. Proceedings of Conference, London, 25–27 March 1969. London; Lead Development Association (1969). 88p. £8. (CONF-690331).

Fifteen papers were presented at the conference. A separate abstract was prepared for each paper. Discussions were published under separate cover. (UK)

For abstracts of individual papers see: 29422, 29487–29494, 29927–29929, and 29948–29950.

29487 CAST LEAD SHIELDS FOR RADIOACTIVE SOURCE TRANSPORT CONTAINERS. Philips, R. J. (Graviner Mfg. Co. Ltd., Gosport, England). 8p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).
See CONF-690331.

The use of cast lead shields for radioactive source containers designed to meet the IAEA requirements is described. The advantages and problems of the use of cast lead shields are discussed and illustrated by reference to specific design and manufacture methods. A comparison between lead filled transport containers and those made from other materials defines the principal areas of future lead usage. (auth) (UK)

29488 THERMAL SHIELDS FOR SHIELDED CONTAINERS FOR RADIOACTIVE MATERIALS. Dixon, F. E. (Atomic Energy Research Establishment, Harwell, Eng.). 9p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).
See CONF-690331.

Experimental work on various thermal shielding materials is described, showing that some apparently unsuitable materials may be successfully used. Among materials considered were wood, cone fibers, chipboard, vermiculite, boron-loaded resin, resin-bonded cork, and steel thermal shields. (UK)

29489 THE REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS AS RECOMMENDED BY IAEA. II. THEIR APPLICATION, NATIONAL AND INTERNATIONAL, AND THE SOLUTION OF PROBLEMS RELEVANT TO SHIELDING OF SPECIAL INTEREST TO THE COMPETENT AUTHORITY. Wilson, E. J.; Partridge, A. H. (Ministry of Transport, London). 9p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).
See CONF-690331.

How the principles of the IAEA regulations have been applied to other international bodies and to the various national regulations of the UK is discussed. The degree of success attained in adoption of the international regulations and what more can be done to enhance unilateral principles are discussed under the following headings: introduction; compatibility between IAEA and international organizations; national regulations; problems associated with heavy shielded packaging (the aim of regulatory requirements with regard to shielding type A and B packagings; large source packaging; regulatory tests; tests for shielding integrity; achievement of regulatory requirements; and proof of achievement). It is emphasized that after approval and issue of the appropriate certificate there is still a responsibility with the consignor to ensure compliance with the regulations regarding dose rate, maintenance of the packaging to the standard assumed for assessment purposes and notifications to the competent authorities regarding changes in the design. Such changes automatically invalidate the approval until after the approving authority has assessed the effect of the modifications and has reissued the certificate of approval. (UK)

29490 USE OF PLASTER FOR INSULATION OF LEAD SHIELDED RADIOACTIVE MATERIALS PACKAGINGS. Blum, P. T. (Transnucleaire SA, Paris). 10p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).
See CONF-690331.

The manufacturing process for a lead shielded-plaster insulated packaging is described together with the advantages and properties of the plaster layer. Details are given concerning the mechanical strength and the thermal properties of the wet plaster, and actual experience of design, manufacture, use and maintenance of these packagings is outlined. Recent developments, such as neutron source or fissile material packagings, are reviewed. (auth) (UK)

29491 THE REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS AS RECOMMENDED BY IAEA. I. THEIR DEVELOPMENT AND STRUCTURE WITH PARTICULAR REFERENCE TO SHIELDING REQUIREMENTS. Fairbairn, A. (United Kingdom Atomic Energy Authority, Risley, Eng.). 12p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).
See CONF-690331.

The broad aim underlying the regulations as recommended by the IAEA, Vienna, for application to all modes of national and international transport of radioactive materials is to attempt to ensure that such regulations promote, rather than impede, contributions from the nuclear industry to the welfare of the community. The regulations are discussed under the following headings: introduction; basic safeguards; ionizing ability X availability = hazard; structure of the regulations e.g., containment safeguards; criticality safeguards; large radioactive source safeguards; external radiation safeguards; and application of regulations. An appendix is included on IAEA (1967) activity limits for packaged radioactive materials. (UK)

29492 A STANDARD RANGE OF CONTAINERS FOR LOADS UP TO 40,000 CURIES OF COBALT OR EQUIVALENT. Dixon, F. E. (Atomic Energy Research Establishment, Harwell, Eng.). 13p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).
See CONF-690331.

A range of containers weighing from ½ lb. to 5,000 lbs. is described. This range was designed to be economical in transport cost and yet meet the stringent environmental test requirements of the IAEA regulations. It is shown that many combinations are possible with relatively few components. (auth) (UK)

29493 PACKAGING FOR LARGE LEAD SHIELDED CONTAINERS FOR RADIOACTIVE MATERIAL. Dixon, F. E. (Atomic Energy Research Establishment, Harwell, Eng.). 18p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).
See CONF-690331.

The packaging principles described are applicable to shielded containers of 5 tons weight and upwards. Such containers are often used for ^{60}Co, which may be in the form of singly contained irradiated material for processing or doubly contained finished rods ready for use in irradiation plants. The containers will carry loads up to 150,000 Ci of ^{60}Co, which will give off about 2.6 kW heat, and require a new type of ventilated thermal shield with a steel crash frame. Packages which come within the scope of the design described are usually designated as "large sources" and are subject to extra provisions in the regulations. The provisions of the regulations which affect this design are: (a) it must be Type B, that is, it must withstand the 30 ft. drop test, followed by the fire test of 800°C for ½ hr; (b) the accessible surface must not be over 82°C; and (c) it must have no external means of cooling. It was found possible to put a ventilated thermal shield around a heat emitting flask and still keep a reasonable temperature both inside and outside the flask, and also that a ventilated insulated drum would protect a bare lead pot during the fire test. Details are given of the design of the thermal shield and of drop and thermal test results. The main conclusion was that with minor modifications a thermal and mechanical shield on the lines described would offer protection to the flask to enable it to be approved as Type B, and that it could have unilateral large source approval. Several packagings to this design have been constructed for containers weighing 5 to 14 tons. (UK)

29494 LEAD SHIELDING IN MEDICAL APPLICATIONS. Stone, F. W. (James Girdler and Co. Ltd., London). 20p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).

See CONF-690331.

A review is presented of the uses of lead in the manufacture of x-ray equipment and shielding, isotope/radium storage and handling, radiotherapy equipment, diagnostic equipment and scanning of isotope tracer elements with particular emphasis on lead collimators, whole body shadow shields, research equipment for cancer diagnosis and treatment, and low-background rooms for measuring radiation in human and animal subjects. The design and operation of metal moulds for the manufacture of some of the lead castings are also described. (auth) (UK)

29495 CURRENT DEVELOPMENT POSITION AND TASKS OF SPECIAL EQUIPMENT ITEMS FOR HOT CELLS. Grosstueck, W. Kerntechnik; 12: 171-4(Apr 1970). (In German and English).

A comparison of advantages and disadvantages of special and conventional equipment in hot cells are considered along with factors which have to be taken into account when using hot cells. Proposals are submitted in order to project and calculate the costs for special equipment with more security and improved utility. (auth)

Vacuum Engineering

Refer also to abstract 29926.

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 29454, 29608, 29613, 29795, 30621, and 31108.

29496 (KAPL-M-7121) 1/v DIELECTRIC TRACK DETECTORS FOR SLOW NEUTRONS. Schultz, W. W. (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar 1970. Contract W-31-109-eng-52. 43p. Dep. CFSTI.

The fabrication of track detectors with boron atoms uniformly dispersed throughout the volume of the track detector material has been successfully accomplished. Because of their small size they have little effect on the neutron flux one is trying to measure. It is possible to make measurements of neutron flux densities over a range of six to seven decades. Track density is found to be a function of the thickness of detector surface etched away and the ranges of the alpha particle and lithium recoil particle resulting from the capture of a neutron by a ^{10}B atom. As etching proceeds, track density may increase or decrease depending on the etching rate of the bulk material relative to the maximum etching rate perpendicular to the particle path. A new method of studying diffusion through thin layers at the surface of a solid is suggested. (auth)

29497 (KAPL-P-3879) ELECTRON MULTIPLIERS AND STATISTICS OF SECONDARY ELECTRON EMISSION. Dietz, L. A. (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract W-31-109-eng-52. 26p. (CONF-700607-1). Dep. CFSTI.

From 18th Annual Conference on Mass Spectrometry and Allied Topics, San Francisco, Calif.

Electron multipliers are extremely sensitive ion detectors which possess very high speeds of response, high detection efficiency and low noise. The electron multiplier detector is discussed mainly as it is used in the pulse-counting mode and some of its advantages and limitations are pointed out. The secondary electron multiplication process is described in terms of a Polya statistical model and its generality is demonstrated by fitting it to a wide range of shapes of observed pulse-height distributions. The Polya model shows how the target or conversion dynode dominates the statistical behavior of an entire detector. Using an Al_2O_3 target surface, preliminary measurements of secondary electron yield as a function of ion mass, impact velocity and angle of entry were made. These results are described. Also, practical considerations in using electron multipliers in either the dc or pulse-counting modes are mentioned. (auth)

29498 (SFL-A-15) MEASUREMENTS OF AIRBORNE RADIONUCLIDES IN FINLAND WITH A HIGH-VOLUME AIR SAMPLER AND Ge(Li) SPECTROSCOPY. Asikainen, M.; Blomqvist, L. (Institute of Radiation Physics, Helsinki (Finland)). Feb 1970. 40p. Dep. CFSTI (U. S. Sales Only).

The use of a high-volume air sampler and Ge(Li) gamma spectroscopy allows very sensitive measurement of several radionuclides in air and makes possible the detection of debris from the nuclear explosions still being conducted in the atmosphere. The methods used in sampling and measurement are described, and the results obtained in 1968-1969 are presented. (auth)

29499 CAPACITANCE MEASUREMENT ON BIASED Ge(Li) AND Si(Li) RADIATION DETECTORS USED WITH COOLED FET INPUT. Kuehn, E. W.; Schroeder, A. N. F. (Univ., Cologne). Nucl. Instrum. Methods; 79: 304-8(1970).

A method is described, to measure the capacitance of cooled pin radiation detectors as a function of bias, by using the standard spectrometry equipment, i.e., a charge sensitive preamplifier, pulse shaping amplifier, multichannel analyzer and a test pulser. A test pulse is coupled through the detector and analyzed. The described slight alteration in the standard detector circuit does not affect the performance of the detector system as a high resolution spectrometer. The method is especially suitable for diodes mounted with cooled FET inside the cryostat, in which case the usual bridge capacitance measurement is not possible because one diode contact is not externally accessible. There is no limit in accuracy down to the lowest bias levels, in contrast to bridge measurement. (auth)

29500 PERFORMANCE OF A SMALL, FAST, HIGH GAIN PHOTOMULTIPLIER TUBE FOR USE WITH SCINTILLATION COUNTER HODOSCOPE ARRAYS IN HIGH ENERGY PHYSICS EXPERIMENTS. Collins, M. W.; Groome, A. E. (Daresbury Nuclear Physics Lab., Eng.). Nucl. Instrum. Methods; 79: 283-5(1970).

A small fast photomultiplier tube has been successfully evaluated for use in scintillation counter hodoscope arrays operating at better than 99% detection efficiency under adverse experimental conditions. (auth)

29501 EFFECT OF A FINITE SIZE SOURCE ON ANGULAR DISTRIBUTION ATTENUATION COEFFICIENTS. Heighway, E. A.; MacArthur, J. D. (Queen's Univ., Kingston, Ont.). Nucl. Instrum. Methods; 79: 224-8(1970).

Exact calculations have been made to determine the effect of a finite source on the attenuation of the angular distribution of gamma-rays. The results show that the effect was small being 0.9% for Q_2 and 2.3% for Q_4 for a 1.0 cm diameter source at 3.34 cm from a 23.0 cm^3 germanium detector. In addition it was found that to good accuracy the exact results could be approximated by using an attenuation coefficient equal to the product of the coefficient calculated for a point source and finite detector, with that for a point detector and a finite source. (auth)

29502 PROGRAM FOR THE ANALYSIS OF TRIPLE CORRELATION MEASUREMENTS. Loos, G.; Kreische, W.; Lampert, W. (Erlangen-Nuernberg Univ., Erlangen, Ger.). Nucl. Instrum. Methods; 79: 229-32(1970). (In German).

A computer program was written for the analysis of $\gamma\gamma$-triple correlations. The structure of the program is discussed by means of a flux diagram. The program is suitable for handling of the correlation both with statistical tensor parameters and with population numbers. (auth)

29503 AVALANCHE CHAIN DEVELOPMENT IN AN ARGON–METHANE PROPORTIONAL COUNTER. Byrne, J. (Univ. of Sussex, Brighton, Eng.); Shaikh, F.; Kyles, J. Nucl. Instrum. Methods; 79: 286-92(1970).

The formation of avalanche chains generated by the release of single slow electrons in an argon–methane proportional counter has been studied by pulse-height analysis of the output produced by such a counter when it is illuminated with ultra-violet light. The statistical distribution of the total number of electrons in the chain of avalanches is found to be in qualitative agreement with the theory although in general the frequency of chains with large numbers of electrons tends to be rather less than predicted. Values of the probability that an avalanche electron should generate a successor avalanche by photoelectric effect at the cathode, derived from analysis of the observed distributions, are in reasonable accord with other published data. (auth)

29504 TRAPPING AND DETRAPPING EFFECTS IN LITHIUM-DRIFTED GERMANIUM AND SILICON DETECTORS. Martini, M.; McMath, T. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods; 79: 259-76(1970).

The trapping-detrapping behavior of Ge(Li) and Si(Li) detectors at low temperatures (T < 77K) has been quantitatively analyzed by means of the phenomenological theory published by J. W. Mayer. The conclusion has been reached that the trapping centers are the primary dopants: Li and Ga in Ge(Li) detectors, Li and B in Si(Li) detectors. Normal spectrometer operation is not affected by these shallow traps because their small activation energies result in very fast detrapping at T ≥ 77 K. A field assisted detrapping effect has been identified for the first time in Ge. This effect allows good spectrometer performance down to at least 8 K at high electric fields. No such field detrapping effect was observed in Si(Li) detectors, so the low temperature limit of operation is established at ≈50 K by the thermal re-emission of carriers from the shallow traps. Deep trapping effects at 77 K in Ge(Li) detectors have also been briefly investigated. A probable explanation is offered for the observed improvement in performance of many detectors at high electric fields. The values of the measured capture cross-sections for trapping of the carriers by the ionized dopants in Ge and Si fall in the same range as those in the literature. This demonstrates the potential of lithium-drifted devices for the study of these processes. (45 references) (auth)

29505 INFLUENCE OF CARRIER DIFFUSION EFFECTS ON WINDOW THICKNESS OF SEMICONDUCTOR DETECTORS. Caywood, J. M.; Mead, C. A.; Mayer, J. W. (California Inst. of Tech., Pasadena). Nucl. Instrum. Methods; 79: 329-32(1970).

Carrier diffusion effects within the depletion region can have a large influence in determining the window thickness x_w of surface barrier detectors. If the surface is assumed to be a perfect sink, carrier diffusion (against the drift field) to the surface leads to

$x_w \approx kT/qE$ where E is the field at the surface. Calculated values of x_w are in reasonable agreement with previously published values of window thicknesses. Surface preparation techniques can influence the amount of charge lost, as can plasma erosion times. (auth)

29506 DETECTION OF INTERNAL CONVERSION ELECTRONS IN CHARGED PARTICLE SPECTRA. Moore, C. F.; Kulleck, J. G.; Coker, W. R.; Clarkson, R. G.; Kent, J. J.; Courtney, W. J. (Univ. of Texas, Austin). Nucl. Instrum. Methods; 79: 353-5(1970).

Internal conversion electrons were detected using cooled Si(Li) detectors. No effort was made to separate the scattered electrons and the scattered protons prior to detection. The resolution obtained was typically 4 keV or better. (auth)

29507 RESPONSE OF NUCLEAR EMULSION TO ELECTRON BEAMS. Katz, R.; Kobetich, E. J. (Univ. of Nebraska, Lincoln). Nucl. Instrum. Methods; 79: 320-4(1970).

A recent theory of particle tracks assumes that the probability P for grain development in nuclear emulsion depends on the local dose E of ionization energy deposited by secondary electrons (delta rays) in the neighborhood of the particle track. The response is assumed to be one of exponential survival; that is, if E_0 is the dose for 37% survival, then $P = 1 - \exp(-E/E_0)$. By calculation of the dose E(t) deposited at depth t in the emulsion by normally incident, monoenergetic electron beams and applying the assumed dose-effect relationship, response curves giving blackness versus electron fluence are obtained, in terms of E_0 and a second parameter combining the effects of the density of undeveloped grains, the developed grain size, densitometer optics, and light scattering. Calculated and measured curves are compared. (auth)

29508 SELECTION OF GERMANIUM FOR LITHIUM-DRIFTED RADIATION DETECTORS BY OBSERVATION OF ETCH-PIT DISTRIBUTIONS. Hansen, W. L.; Pehl, R. H.; Rivet, E. J.; Goulding, F. S. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Instrum. Methods; 80: 181-6(1970).

This note establishes the value of observation of etch-pit distributions as a guide in the selection of germanium for use in lithium-drifted germanium detectors. Results are presented showing a very good correlation between the etch-pit distribution and detector performance for a number of crystals pulled on the 111 axis. It is inferred that mechanical strain produced by thermal conditions in the crystal growing process is the major source of potential charge trapping sites in the final detector. (auth)

29509 PRECISION MEASURING DEVICE FOR COMPARING THE SOURCE STRENGTHS OF NEUTRON SOURCES. Hochhaeuser, E.; Schoenfeld, E. (Deutsches Amt fuer Messwessen und Warenpruefung, Berlin). Nucl. Instrum. Methods; 80: 347-50(1970). (In German).

Equipment is described for comparing neutron source strengths within ±0.5%. It contains six BF_3 counters in a paraffin moderator with separate amplifiers in each channel to allow fair discrimination against γ's and to reduce pulse pile up. (auth)

29510 EFFECT OF NUCLEAR REACTIONS IN THE RESPONSE OF STACKED SILICON DETECTORS. Makino, M. (Univ. of California, Santa Barbara); Eisberg, R.; Richie, K.; Carlson, R.; Waddell, C. Contracts AT(11-1)-34; AT(04-3(-136. Nucl. Instrum. Methods; 80: 299-303(1970).

Measurements are reported of the percentage of pulses of reduced height due to nuclear reactions in Si detectors bombarded by monoenergetic protons. The results of these measurements are: 45.3 MeV, 3.39 ± 0.04%; 37.5 MeV, 2.51 ± 0.04%; 27.5 MeV, 1.39 ± 0.04%; 12.9 MeV, 0.215 ± 0.022%. These results are compared to values predicted from proton total reaction cross sections. (auth)

29511 FANO FACTOR IN SILICON AT 90 K. Eberhardt, J. E. (Australian Atomic Energy Commission, Lucas Heights). Nucl. Instrum. Methods; 80: 291-2(1970).

A Fano factor of 0.084 ± 0.005 has been measured at 90 K in a silicon surface-barrier X-ray detector made from 20 000 Ω/cm n-type silicon. (auth)

29512 STUDY OF THE CHARACTERISTICS OF A 120 cm^3 Ge(Li) DETECTOR AND COMPARISON WITH SMALLER DETECTORS. Irigaray, J. L.; Petit, G. Y. (CEN, Bordeaux, Faculte des Sciences, Gradignan, France). Nucl. Instrum. Methods; 80: 264-7(1970). (In French).

We show some gamma ray energy spectra obtained with a 120 cm^3 active volume Ge(Li) detector. Energy resolution and counting efficiency curves versus energy for total absorption peak and double-escape peak are drawn. In addition, a comparison between characteristics is made with smaller detectors and some conclusions are deduced for great detector volume uses. (auth)

29513 ANALYSIS OF RESPONSE DATA FOR SEVERAL ORGANIC SCINTILLATORS. Craun, R. L.; Smith, D. L. (Army Missile Command, Redstone Arsenal, Ala.). Nucl. Instrum. Methods; 80: 239-44(1970).

Data on the scintillation response (light output) of anthracene, stilbene, NE-213, NE-102 and Pilot-B to electrons and protons and of NE-230 to electrons and deuterons reported recently by Smith et al. have been fitted by the method of least squares to the parametric formula $L(E) = S \int_0^E d\epsilon[1 + kB(dE/dx) + C(dE/dx)^2]^{-1}$ where E is the initial particle energy, dE/dx is the specific energy loss, and S, kB and C are the adjustable parameters. Required values of dE/dx were computed from available data. Scintillation efficiencies S were deduced from the electron data for which $dE/dx \approx 0$. One-parameter (kB variable, C = 0) and two-parameter (kB and C variable) fits for the heavy-particle data were obtained and compared with other results reported in the literature. (auth)

29514 RADIOLUMINESCENCE OF LEAD CHLORIDE. Czegledy, S. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 28: 121-3(1970).

The cooled lead chloride which shows a blue luminescence seems in many respects, to have considerable advantages as a scintillator material. However, because of its unfavourable response and poor energy resolution, it cannot be used for gamma-spectroscopic purposes. No activator has so far been found which could render the lead chloride crystal luminescent at room temperature also. (auth)

29515 INVESTIGATIONS ON TERNARY PHOTOFISSION BY MEANS OF PLASTIC AND MICA TRACK DETECTORS. Medveczky, L. (Inst. of Nuclear Research, Debrecen, Hungary); Somogyi, G.; Goetz, G. Acta Phys. Acad. Sci. Hung.; 28: 169-84 (1970).

The aim of the present investigations was to obtain data for the ternary photo-fission of ^{232}Th, ^{238}U, and ^{239}Pu induced by 27.5 MeV bremsstrahlung. Sandwiches, made of solid-state track detectors, were used for the detection of the binary and ternary fissions. For the purposes of distinguishing between symmetrical and asymmetrical ternary fission events, our investigations were carried out simultaneously with two track detectors (mica and plastics) with different registration thresholds. The experimental methodology, i.e., the preparation of the sandwiches, the method of angle and range measurement and track evaluation are described. About 1.5 million binary fission events were scanned. Data are given for the frequency of occurrence of three-prong and two-prong events with a spatial angle of less than 165°. Data are also presented for the angular and range distributions measured for these events. The possible disturbing scattering phenomena and the methods of eliminating them are discussed. It has been established that the ratio of symmetrical ternary-fission events (the mass of each fragment being >30) to binary fission events, in the case of ^{232}Th, ^{238}U, and ^{239}Pu are $\sim 8 \cdot 10^{-6}$, $\sim 11 \cdot 10^{-6}$, and $< 3 \cdot 10^{-6}$, respectively. The relative frequency of occurrence of asymmetrical ternary fissions (the mass of one of the fragments being between 10 and 30) seems to be several times more. (auth)

29516 LIQUID-SCINTILLATION ASSAY OF ^{45}Ca IN BONE AND OTHER BIOLOGICAL TISSUE. Kramer, C. F.; Ross, B. H. (Univ. of British Columbia, Vancouver). Int. J. Appl. Radiat. Isotop.; 21: 237-8 (Apr 1970).

Comparisons of techniques for preparing samples for liquid scintillation counting of ^{45}Ca in bone and carcass were made. Criteria for choice were simplicity and precision of procedure, counting efficiency and adaptability to automate computation. The method of evaporating HCl solution of ashed tissue on filter paper was found to be the most reliable and simplest. (UK)

29517 TIME RESOLUTION MEASUREMENTS WITH XP1021 PHOTOMULTIPLIERS. Sen, P.; Patro, A. P. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Instrum. Methods; 81: 197-8 (1970).

A time resolution (fwhm) of 135 ps with slopes of 22 ps for ^{60}Co source accepting 300 to 930 keV energy loss, i.e., 68% of Compton in side channels using Pilot B, and a time resolution (fwhm) of 430 ps with slopes of 96 ps for ^{60}Co source accepting 1.17 – 1.33 Mev photopeaks in side channels using NaI(Tl) phosphors, have been obtained with XP1021 photomultiplier tubes in a set up having a differential time-to-amplitude converter and a compensator. (auth)

29518 REALIZATION OF AN ASSEMBLY FOR THE DETECTION AND IDENTIFICATION OF CHARGED PARTICLES BY ON-LINE CALCULATING. Merchez, F.; Pouxe, J.; Tournier, M. (Institut des Sciences Nucleaires, Grenoble, France). Nucl. Instrum. Methods; 81: 173-82(1970). (In French).

The set-up presented here has been used in the $^{6}Li(n, p)$ experiment and has been particularly studied for experiments close to the previous one as regards the acquisition rate and on-line calculations to be made. As far as the detection part of the set-up is concerned, attention has been particularly focused on the maximum elimination of the background resulting from the reactions caused by the fast neutrons in the detectors. As for the logic part of the set-up, its originality lies in the use of standard circuits connected to a small computer and allowing the acquisition, the handling and the output of the data with a range of possible uses that compares to the ones of much bigger units. (auth)

29519 SPECTRA DENSITY METHODS IN THE PERTURBED ANGULAR CORRELATION MEASUREMENTS. Rama Reddy, K. (Univ. of Illinois, Urbana). Nucl. Instrum. Methods; 81: 183-8 (1970).

Using the techniques of random signal analysis we have calculated the frequency spectra of the perturbed angular correlation measurements. The frequency spectra contain "resonances" whose positions are determined by the hyperfine interactions. In the absence of relaxations, line width of a resonance is just the natural line-width of the nuclear state. For various perturbation parameters numerical results are presented. (auth)

29520 PARALLEL PLATE IONIZATION CHAMBER WITH GAS MULTIPLICATION. Sikkema, C. P. (Rijks Univ., Groningen, Netherlands). Nucl. Instrum. Methods; 81: 189-94(1970).

The signal-to-noise ratio in a parallel plate ionization chamber has been improved by the addition of a gas amplification system. The electric field in the system is investigated and equations are given which the potentials on the electrodes should satisfy. Some results obtained when using the instrument to determine the orientation of particle tracks are presented. (auth)

29521 METHOD FOR REDUCING THE EFFECT OF NUCLEAR REACTIONS IN STOPPING DETECTORS. Makino, M. (Univ. of California, Santa Barbara); Eisberg, R.; Ingram, D.; Waddell, C. Contracts AT(11-1)-34; AT(04-3)-136. Nucl. Instrum. Methods; 81: 125-31(1970).

The tail of lower energy pulses due to nuclear reactions of incident particles in a stopping detector causes difficulty in the measurement of inelastically scattered particles. But it is possible to separate lower pulse height events arising from nuclear reactions from those due to "true" low energy particles by comparing the spatial energy loss distribution observed in the detector to that predicted from the range-energy relation for "true" particles. This is accomplished by dividing the detector into a number of laminae, and recording the energy loss in each. Two methods of treating the information that is obtained are described. Results are presented for protons of energies up to 45 MeV incident on a Si detector stack consisting of four equal laminae. (auth)

29522 MONTE CARLO CALCULATION OF THE ENERGY LOSS SPECTRA FOR GAMMA RAYS IN CYLINDRICAL NaI(Tl) CRYSTALS. Giannini, M.; Oliva, P. R.; Ramorino, M. C. (CNEN, Rome). Nucl. Instrum. Methods; 81: 104-8(1970).

A Monte Carlo calculation to determine the pulse height response of NaI(Tl) crystals to γ-rays is described. The calculation program is reliable for γ-ray energies up to about 20 MeV. An improvement for what concerns the electron slowing down and the bremsstrahlung treatment has been introduced. Comparisons are made with experimental data and other calculated results. (auth)

29523 TIMING PROPERTIES OF SCINTILLATION COUNTERS. Bengtson, B.; Moszynski, M. (Univ. of Aarhus, Denmark). Nucl. Instrum. Methods; 81: 109-20(1970).

The study of time resolution as a function of the triggering fraction C/R for NE111 and Naton 136 scintillators of different dimensions and XP1021 photomultipliers showed that the shape of C/R curves and in particular the optimum of C/R values depend strongly on the type and dimension of scintillators. Including a new description of the light pulse from a scintillator as a convolution of an exponential function with a Gaussian function to the Hyman theory gave a quantitative agreement of experimental and theoretical C/R curves. The values of parameters describing the timing properties of the photomultiplier XP1021 and the scintillators were found. The previously reported disagreement between the measured time resolution versus absorbed energy and the predictions of Gatti and Svelto, and of Hyman, is shown to be removed when the experiments are performed with a realistic choice of energy window settings. The study of C/R curves with constant fraction timing shows a shift of the optimum to the higher value of C/R. The time resolution for ^{60}Co is $\approx$ 30% better than with leading-edge timing even for 20% pulse height selection. The measurements show that the new NE111 scintillator is faster than Naton 136. For NE111, the present limitation in the obtainable time resolution appears to be the time jitter of the photomultiplier while in the case of Naton 136 the limitation is given by a time spread of light pulse generation. A time resolution of 132 ps for ^{60}Co and 216 ps for ^{22}Na was obtained using NE111 scintillators with 2.5 cm diameter and 1.0 cm height. (auth)

29524 DESIGN AND PERFORMANCE OF AN INSTRUMENT FOR DETERMINING THE CHEMICAL COMPOSITION OF PRIMARY COSMIC RADIATION. Corydon-Petersen, O.; Dayton, B.; Lund, N.; Melgaard, K.; Omoe, K.; Peters, B.; Risbo, T. (Danish Space Researeh Inst., Lundtoftevej). Nucl. Instrum. Methods; 81: 1-12(1970).

An instrument is described which is suitable for the chemical analysis of primary cosmic radiation in the energy range above 1 GeV/nucleon. A prototype has been tested in two balloon flights and the charge and velocity of approximately 6000 nuclei of atomic number $Z \geq 3$ have been measured. For oxygen and for nuclei lighter than oxygen the error in determining Z (standard deviation) is $\approx$0.26, and for iron nuclei it is $\approx$0.32 units of charge. This resolution corresponds to a probability of 6% and 12%, respectively, of wrongly assigning a nucleus to one of its immediate neighbors in the atomic table. Possible improvements of the instrument are discussed. (auth)

29525 EXPERIMENTAL STUDY OF THE ACCURACY OF COMPENSATION IN LITHIUM DRIFTED GERMANIUM DETECTORS. Lauber, A.; Malmsten, B. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Instrum. Methods; 81: 77-84(1970).

The nature and magnitude of the space charge existing in the compensated layer of lithium drifted germanium detectors has been studied as a function of drifted depth and of the electric field applied during drift. Experimental values were obtained from the dependence of detector capacitance on applied bias. In most cases there was a linear space charge gradient in the compensated layer. When small electric fields were applied to deep compensated layers, the space charge became constant throughout a large part of the compensated layer. There is some evidence for a strong decrease of mobile carrier recombination lifetime with increasing drifted depth, possibly down to a few microseconds for drifted depths of the order of 7 mm. The experimental results of the investigation are to a large extent in good agreement with theory. (auth)

29526 SCINTILLATION COUNTER WITH IMPROVED UNIFORMITY AND SOME CHARACTERISTICS OF FLEXIBLE LIGHT GUIDES. Lehraus, I.; Matthewson, R. (CERN, Geneva). Nucl. Instrum. Methods; 81: 85-92(1970).

Three different light guides for a 10 × 10 cm NE 110 plastic scintillator and 56 AVP photomultiplier assembly were compared. Absorption in long 5 mm diameter flexible plexiglass light guides was measured as a function of bending radius. An example of application of a glass fiber light guide for a scintillation finger-counter is described. (auth)

29527 CORRECTION FOR FISSION NEUTRON DETECTOR EFFICIENCY AND UNFOLDING OF NEUTRON MULTIPLICITY HISTOGRAMS. Nifenecker, H. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Instrum. Methods; 81: 45-8(1970).

The use of group theory and characteristic functions provides an elegant derivation of formulas relating the true neutron number probabilities to the observed ones. The method allows a straight forward generalization of these formulas. (auth)

29528 UNDERWATER NEUTRON COUNTER FOR ESTIMATING ^{252}Cf IN REACTOR TARGETS. Herold, T. R. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Nucl. Instrum. Methods; 81: 49-55(1970).

An underwater neutron counter was designed to assay nondestructively ^{252}Cf buildup in ^{242}Pu targets, by measuring spontaneous fission neutrons from the ^{252}Cf. The counter reliably measures up to 10^{10} neutrons/second, and operates satisfactorily in the presence of gamma activities up to 4000 Ci at the target test position. The counter operates 30 ft underwater to permit measurements during short reactor shutdowns. The counter monitored the ^{252}Cf buildup in ^{242}Pu targets that were irradiated during the SRP High Flux Demonstration and the SRP ^{244}Cm campaign. The counter measurements of ^{252}Cf agreed with subsequent destructive chemical analyses within ±5%. Neutron counts from a given target were reproducible within ±2%. (auth)

29529 AUTOMATIC NUCLEAR-EMULSION SCANNER. Erskine, J. R.; Vonderohe, R. H. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 81: 221-38(1970).

A scanning machine has been built to process nuclear track plates exposed in a broad-range magnetic spectrograph. The scanner, which has been in use for almost two years, uses a PDP-9 digital computer to do pattern recognition and to control the scanning head. A high-resolution image-dissector tube scans the emulsion with a resolution width of about 5 μm. Many technical problems were solved to obtain good, stable signals of high resolution from typical tracks in nuclear emulsions. The computer identifies objects as tracks if they have the proper length, width, and orientation. The machine scans 30–40 times faster than the typical human scanner. Counting accuracy is found to be influenced by brightness of tracks, length of tracks, number of tracks in a given area, fog level in the emulsion, and dirt. For the majority of plates exposed in the magnetic spectrograph, good counting accuracy is achieved except in regions of high track density. (auth)

29530 LOW TEMPERATURE (77°K) FISSION DETECTOR. Eggermann, C.; Blons, J.; Dumazert, M.; Pranal, Y. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nucl. Instrum. Methods; 81: 243-52(1970). (In French).

We describe a fission detector which has been developed for measurements with high resolution of the neutron induced fission cross section of very radioactive fissile nuclei. In this apparatus, detection is accomplished by observing with photomultipliers the scintillations produced by the fission fragments in a mixture of helium and nitrogen. The fissile material is cooled to a temperature of 77°K to reduce Doppler broadening. In order to obtain good statistical accuracy compatible with high resolution, the detector is designed to contain a large quantity of fissile material (e.g., 1 g of ^{239}Pu). The first application of this detector was the measurement of the fission cross section of ^{239}Pu by the time-of-flight method using the Saclay 45 MeV linear accelerator as a pulse neutron source with a nominal resolution of 1 ns/m. The results obtained are presented and compared with previous measurements. (auth)

29531 WALK CORRECTION FOR SCINTILLATION COUNTERS. Brady, F. P. (Atomic Energy Research Establishment, Harwell, Eng.); Bonner, B. E. Nucl. Instrum. Methods; 81: 280-4(1970).

A technique is presented which minimizes time walk in scintillation counters. The technique utilizes two leading edge discriminators, pulse shaping, and an additional TAC; and yields a best result of ±85 ps over a dynamic range of 100 for 56 AVP pulses simulating those observed from plastic scintillator. Measurements of time walk are also given for NaI. Some measurements of statistical time dispersion are reported. (auth)

29532 A SIX-FOOT LONG DETECTOR FOR NEUTRON TIME-OF-FLIGHT EXPERIMENTS. Neilson, G. C.; Glavina, C.; Dawson, W. K.; Iyengar, K. V. K.; McDonald, W. J. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods; 81: 301-4(1970).

A six-foot detector, covering an angular range of 17° at a distance of 6 m, has been developed. It has a time resolution in the range of 1 of 2 ns for an electronic threshold equivalent to 1.2 MeV neutrons. The angular resolution, obtained by determining the location of the source of scintillation in the detector by time-of-flight techniques, is approximately 3°. (auth)

29533 A FISSION COUNTER INSENSITIVE TO ALPHA-PARTICLES. Scheer, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Instrum. Methods; 81: 335(1970).

A parallel plate avalanche counter is described which is insensitive to α-particles but yields large signals for fission fragments related to their energy loss. (auth)

29534 ELIMINATION OF THE TIME DEPENDENCY OF HIGH ALPHA FLUX DENSITIES FROM n,α-CONVERSION LAYERS. Graul, J.; Ruge, I. (Technische Hochschule, Munich). Nucl. Instrum. Methods; 81: 334(1970).

The time dependency of the alpha flux from a n,α-conversion layer can be eliminated for a certain operating time by an additional layer. The required characteristics are calculated. (auth)

29535 RECENT OBSERVATIONS ON THE FANO FACTOR IN GERMANIUM. Pehl, R. H.; Goulding, F. S. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Instrum. Methods; 81: 329-30(1970).

Results demonstrating that the Fano factor for germanium is less than 0.08 are presented. (auth)

29536 THE USE OF FERROELECTRICS IN THE DETECTION OF NUCLEAR RADIATION. Glower, D. D.; Miller, D. W.; Schlosser, P. A. (Ohio State Univ., Columbus). Int. J. Nondestruct. Test.; 1: 191-212(Oct 1969).

The theories which describe ferroelectrics are presented to demonstrate the source of the properties which are utilized when these materials are used in detecting and measuring energy. The pyroelectric effect, the piezoelectric effect and the Barkhausen effect provide three different modes of operation for nondestructive testing. A penetrating radiation, such as X-rays, is detected through the large pyroelectric coefficients. The advantages of these detectors are that they do not require external bias power supplies, they can measure very intense energy fluxes with a linear response, they can be fabricated to any desired geometry or size, and they respond to any form of energy which is absorbed at their surfaces. For conditions where the sensitivity is too low, the surface area which is active can be increased by stacking many thin disks into a composite detector. (auth)

29537 SCINTILLATION RADIOLOGICAL SURVEY METERS. Ello, J. G. (Argonne National Lab., Ill.). Electron. World; 83: No. 1, 39-43(Jan 1970).

The design and operation of scintillation detector survey meters are discussed. The operation and maintenance procedures for the PAC-1S survey meter are described. (W.H.K.)

29538 APPLICATION OF IMAGE INTENSIFIER TO STUDY OF AIR SHOWER. Matano, Tsuneo (Saitama Univ., Urawa, Japan). Uchusen Kenkyu; 14: 281-2(Oct 1969). (In Japanese).

A large-area detector of high resolution is required for the study of the multicore at the center of an air shower of high energy hadrons. The detectors used at present for this purpose are reviewed. Discharge chambers, neon hodoscopes, cloud chambers, mosaic scintillators, calorimeters, etc., are compared, and their advantages are given in tables. The application of an image intensifier is then discussed. The combination of scintillators and an image intensifier is used for the observation of a double core. For a large area, this is more economical than mosaic scintillators. For the observation of high energy hadrons, the combination of an ECC and scintillators can be used with an image intensifier. The possibility of photographic recording was examined. It was shown that a detector with an area of 10 to 20 m^2 is possible in this way. The result of the experiment was discussed. The spatial resolution turned out to be lower than expected. (NSA of Japan)

29539 SPARK CHAMBER FOR THE OBSERVATION OF AIR SHOWER. Nagano, Motohiko (Tokyo Univ.). Uchusen Kenkyu; 14: 286-8(Oct 1969). (In Japanese).

The technical problems associated with the spark chambers used at the Institute for Nuclear Study for the observation of air showers are discussed. At the Institute, 66 spark chambers are used in the area of 20 m^2. The working gas is neon at atmospheric pressure. About 5% are damaged yearly. The following improvements are required. (1) Simplification both in maintenance and in data analysis. Uniform spot brightness should be realized for automatic data extraction, and the technical problems associated with this are discussed. (2) Spatial resolution and multiple efficiency. The center of an air shower larger than 5×10^5 cannot be resolved at present. A possible remedy is discussed. (3) Ionization discrimination. In order to determine the position of burst caused by Pb, the application of the special technique developed by Greider and by the Nagoya Univ. group is considered. (NSA of Japan)

29540 DEVICE FOR MEASURING RADIATION INTENSITY. Arutyunov, G. K.; Dzhagarov, Yu. A. (to Inst. of Cybernetics, Tbilisi, USSR). Russian Patent 232,548. 7 Apr 1969. Filed 3 Jun 1967. (In Russian).

A device for measuring radiation intensity is proposed. For the purpose of increasing the stability of measurements, the device is made in the form of a triangular prism from material whose maximum spectral absorption fits the studied radiation, whereby one face of the prism is coated with luminescent compound, which is excited by the studied radiation, and the second face is coated with light reflecting compound. The face of the prism coated with a luminescent compound is equipped with a scale which makes possible visual determination of the radiation intensity according to the boundaries between the light and dark regions of the luminophor emission. (JPRS)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 30727.

29541 (AE-393) A GAMMA SCANNER USING A Ge(Li) SEMICONDUCTOR DETECTOR, WITH THE POSSIBILITY OF OPERATION IN THE ANTICOINCIDENCE MODE. Forsyth, R. S.; Blackadder, W. H. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Apr 1970. 21p. Dep. CFSTI (U. S. Sales Only).

A fuel element transport flask has been modified as a facility for gamma scanning irradiated fuel elements up to a length of 75

cm. By means of a Ge(Li) semi-conductor detector, satisfactory activity profiles along the specimens have been obtained, permitting the location of individual fuel pellets. An annular plastic detector surrounding the Ge(Li) detector allows operation of the spectrometer in the anti-coincidence mode, and reduction of the Compton continuum by about 50% has been obtained. (auth)

29542 (RT/PROT-(69)39) APPARATUS FOR LOW-LEVEL RADIOACTIVITY MEASUREMENTS WITH GAMMA–GAMMA COINCIDENCE SPECTROMETER. Cigna, A. A.; Clemente, G. F.; Giorcelli, F. G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). [1969]. 10p. Dep. CFSTI (U. S. Sales Only).

A new kind of apparatus using the sum-coincidence gamma-gamma method is described. The minimum detectable amounts of the following radionuclides are reported: Na 22, Ru–Th 106, Co 60, Y 88, Ba–La 140, Ce–Pr 144. Such minimum detectable amounts were evaluated taking into account the interference of other radionuclides present in the sample. (auth)

29543 (SAN-549-5) RESEARCH AND DEVELOPMENT ON SINGLE CRYSTAL HIGH RESISTIVITY CADMIUM TELLURIDE FOR USE AS A GAMMA RAY SPECTROMETER. Interim Progress Report, 1 January–31 December 1968. Zanio, Kenneth R. (Hughes Research Labs., Malibu, Calif.). Jun 1970. Contract AT(04-3)-549. 59p. Dep. CFSTI.

Single crystals of semi-insulating CdTe which have a substantial increase in the values of the mobility trapping time product for electrons (2×10^{-4} cm^2/V) and holes (3×10^{-5} cm^2/V) have been grown from the melt by a modified Bridgman technique. Photopeaks have been observed on surface barrier detectors using monoenergetic gammas from 122 keV to 840 keV. A photopeak resolution of 15% (FWHM) has been observed using monoenergetic gammas from ^{113}Sn (393 keV). The shape of the photoelectric and Compton spectra is treated theoretically and found to agree with experimental results. Degradation in photopeak resolution for improved material is attributed to fluctuations in hole trap density and a geometric effect. Further improvement in resolution can be attained by reducing fluctuations in the hole trap density and the density of traps. (auth)

29544 CONVOLUTION ANALYSIS OF PULSE-HEIGHT DISTRIBUTIONS. Rossitto, F.; Terrani, M. (CESNEF, Milan). Nucl. Instrum. Methods; 79: 341-5(1970).

The possibilities offered by a particular application of the convolution technique to the quantitative analysis of pulse-height distributions are treated and discussed. (auth)

29545 COMPUTER ANALYSIS OF NUCLEAR SPECTRA AND γ-ENERGY STANDARDS. Kern, Jean (Univ., Fribourg, Switzerland). Nucl. Instrum. Methods; 79: 233-9(1970).

After a review of the most accurately known gamma calibration lines, we present a method of obtaining new secondary standards of similar precision, but extending to higher energies. In our approach, we simultaneously use the pair-peak method, energy combinations, experimental non linearity curves, averages over several measurements and accurate peak position determinations. The latter is obtained in fitting the spectra by an appropriate analytical expression. The new calibration lines extend up to 2 MeV and exhibit precisions between 15 and 40 eV. They belong to the decays of ^{88}Y, ^{110m}Ag, ^{140}La and ^{207}Bi. (auth)

29546 BACKSCATTERING OF ELECTRONS ON ALUMINUM AT 0.25 AND 0.5 MeV. Jakschik, J.; Juengst, K. P. (Freie Univ., Berlin). Nucl. Instrum. Methods; 79: 240-4(1970). (In German).

Measurements of energy spectra of 0.25- and 0.5-MeV electrons backscattered from aluminum foils, 2.5 up to 110 mg/cm^2 thick, are reported. The angular distributions and the backscattering coefficients are given, too. Energy spectra for scattering angles near to 90° from the direction of the incident beam show a peak, due to single scattering. The variation of the most probable energy loss with the target thickness is shown and functions are given for the dependence of the most probable energy loss on the primary energy and of the maxima of the angular distributions on the target thickness. The angular distribution for saturation thickness and the dependence of the backscatter fraction on the target thickness are found to be in good agreement with Monte Carlo calculations of Berger. (auth)

29547 MEASUREMENT OF TOTAL PHOTONUCLEAR CROSS SECTIONS USING A NOVEL METHOD OF PHOTON SPECTROSCOPY. Wu, C. P. (Yale Univ., New Haven); Firk, F. W. K.; Berman, B. L. Nucl. Instrum. Methods; 79: 346-8(1970).

The potentialities of a photon spectrometer, utilizing neutron time-of-flight measurements from deuteron photodisintegration, are demonstrated by measuring the photon absorption cross section of carbon between 20 and 30 MeV. (auth)

29548 PULSE SHAPE DISCRIMINATION WITH A COMPARATOR CIRCUIT. Heistek, L. J.; Van der Zwan, L. (National Research Council of Canada, Ottawa). Nucl. Instrum. Methods; 80: 213-16(1970).

The pulse shape discriminator described employs an integrated circuit differential comparator to measure the zero cross-over time of a bi-polar pulse relative to the start of the pulse. The comparator element operates over a dynamic range of 0.02 to 10 V with a time shift of less than 4 ns for DDL pulses with a rise time of 100 ns. The pulse shape discriminator includes pile-up rejection and dead-time circuitry to reduce count rate effects. The energy dependence of the pulse shape for NE 213 and stilbene is measured from 0.2 to 4 MeV electron equivalent energy. The low energy performance for a small stilbene scintillator is studied from 18 to 92 keV electron equivalent energy. (auth)

29549 IMPROVED METHODS IN THE ANALYSIS OF NON-STATISTICAL BETA SPECTRA. Nagarajan, T. (Univ. of Madras); Reddy, K. Venkata. Nucl. Instrum. Methods; 80: 217-28(1970).

With a view to eliminating all possible uncertainties in the method of analysis of linear and curvilinear shape deviations, the correlation between the endpoint energy and the shape factor coefficients including the modified B_{ij} shape parameter D is thoroughly discussed. In contrast to the earlier methods which are either insensitive or unreliable, an ordered sequence of analysis which is physically very significant is developed. The method is highly sensitive and the effects on the shape factor of the unknown parameters can be individually studied. (auth)

29550 SEPARATION BY SUCCESSIVE α RECOILS IN VACUUM OF THE ELEMENTS OF A RADIOACTIVE SERIES. Briand, J. P.; Chevallier, P. (Institut de Physique Nucleaire, Paris). Nucl. Instrum. Methods; 80: 309-12(1970). (In French).

We study the rate of re-emission by α recoil of atoms which have entered a metallic foil, by α recoil in vacuum. An automatic device to collect and study radioactive atoms of very short half lives (300 μs), by collection in vacuum of second order α recoil, is described. (auth)

29551 APPLICATION OF A PULSE SHAPE SELECTION METHOD TO A TRUE COAXIAL Ge(Li) DETECTOR FOR MEASUREMENTS OF NANOSECONDS HALF-LIVES. Moszynski, M.; Bengtson, B. (Univ. of Aarhus, Denmark). Nucl. Instrum. Methods; 80: 233-8(1970).

A study of the pulse shape distribution from a 35 cm^3 true coaxial Ge(Li) detector has been performed for uniform γ-irradiation. Two well defined pulse-shape groups were found which could be separated completely by CR differentiation. The prompt time spectrum derived from the earlier group of pulses gave a fast and exponential slope over more than four decades. By this method it was possible to identify a very weak and delayed transition in the nanosecond range. (auth)

29552 A METHOD FOR CALIBRATING A PROTON-RECOIL SPECTROMETER. Rogers, J. W. (Idaho Nuclear Corp., Idaho Falls). Nucl. Instrum. Methods; 80: 313-19(1970).

A method is described for calibrating the energy sensitivity of proton-recoil spectrometer with neutrons of accurately known energy. The sources of neutrons for this calibration are the scandium and iron filtered neutron beams of the Materials Testing Reactor-Western Beam Research Reactor (MTR-WBRR). The energies of the neutrons in these beams are precisely known from time-of-flight measurements. The primary advantages of this method are that it (a) simulates the actual nuclear processes involved during the measurement of an unknown spectrum, (b) provides several points of calibration distributed over much of the energy range of proton-recoil spectrometers, (c) eliminates the necessity of adding, for calibration purposes, extraneous material or radiation to the detector for which corrections may have to be made when measuring an unknown spectrum, and (d) presents a method of observing the effects of, W, the energy loss per ion pair for the detector gas. (auth)

29553 ELECTRONIC CIRCUIT FOR INCREASING THE RESOLUTION OF A MOESSBAUER SPECTROMETER. Beltran-Lopez, V. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Nucl. Instrum. Methods; 81: 195-6(1970).

A simple external electronic circuit for increasing the resolution of a Moessbauer spectrometer operating in time-mode is described. This circuit permits the utilization of all the channels available in the analyzer for observation of the Moessbauer spectrum in the velocity ranges $v = -V_{max}$ to $v = +V_{max}$, or $v = 0$ to $v = \pm V_{max}$, thus increasing the velocity resolution of the apparatus by a factor of 2 or 4. (auth)

29554 BINARY SEQUENCES AND ERROR ANALYSIS FOR PSEUDO-STATISTICAL NEUTRON MODULATORS WITH DIFFERENT DUTY CYCLES. Wilhelmi, G.; Gompf, F. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods; 81: 36-44(1970).

Pseudo-statistical choppers have been used successfully in time-of-flight measurements with slow neutrons. The question of how to construct a chopper in order to minimize a suitably defined statistical error of the time-of-flight distribution is studied. A class of pseudo-statistical choppers with different time utilization of the reactor beam, including those pseudo-statistical choppers already used which have been constructed with the help of shift registers are examined. The more general concept of difference sets well known in combinatorial mathematics is applied. An extensive error analysis of this class of pseudo-statistical choppers is included. (auth)

29555 DESCRIPTION OF A MOESSBAUER SPECTROMETER USING A PIEZOELECTRIC BAR. Schmidt, K.; Dierieck, C.; Lafaut, J. P.; Vermeulen, E.; Elskens, M. (Leuven Univ., Belg.). Nucl. Instrum. Methods; 81: 211-13(1970).

A piezoelectric transducer is used as a velocity drive for a Moessbauer spectrometer. A description of the apparatus and the result of a test with ^{57}Fe are given. (auth)

29556 STUDY ON THE ARRANGEMENT OF SLITS FOR FAST CHOPPER. Ono, M.; Yamada, S.; Okamoto, S. (Kyoto Univ., Osaka). Nucl. Instrum. Methods; 81: 214-16(1970).

The arrangement of slits for fast chopper has been improved in order to simplify the time dependency of its background and also to strengthen the slits against the induced centrifugal force. (auth)

29557 COMPUTER PROGRAM FOR AUTOMATIC ANALYSIS OF γ-RAY SPECTRA. Mills, S. J. (Commonwealth Scientific and Industrial Research, Pretoria). Nucl. Instrum. Methods; 81: 217-19(1970).

A FORTRAN IV(G) computer program is reported which automatically locates all the significant peaks in a read-in γ-ray spectrum and determines their centers and areas. (auth)

29558 STATISTICAL CONSIDERATIONS IN HALF-LIFE MEASUREMENT. I. Jaffey, A. H. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 81: 155-63(1970).

In this paper and in its to-be-published sequels, some of the factors affecting the statistical error and systematic error (bias) in half-life estimation are examined from a statistical viewpoint. These factors include: (1) the length of the observation period, (2) whether background is present, (3) whether one decaying species or several are present, (4) the effect of grouping measurements in time intervals, (5) the effect of not using the mean time-value in a counting interval, (6) the effect of error in time measurement, (7) the effect of the logarithmic transformation in least-squares curve-fitting, (8) the effect of using measured counting rates for weights, (9) a correlation effect with few counting intervals, (10) a correlation effect due to use of a single background measurement for an entire decay curve, (11) efficient pooling methods for the results of multiple experiments, (12) optimum choice of truncation time when multiple samples are used, and (13) the effect of non-Poisson count distributions when genetically related species are counted. Factors (1)–(4) are considered in this paper. (auth)

29559 CONSTRUCTION OF A RESPONSE MATRIX FOR γ SCINTILLATION SPECTROMETRY. Brust, R.; Richter, D. (Deutsches Amt fuer Messwesen und Warenpruefung, Berlin). Nucl. Instrum. Methods; 81: 132-40(1970).

The use of an inverse response matrix to unfold pulse height distributions gives rise to difficulties which appear in the unfolded spectra as disturbing oscillations. An attempt is made to construct a response matrix with an accuracy as high as possible and to demonstrate in this way the influence of this accuracy on the results of the unfolding procedure in comparison with disturbing sources which furthermore occur. Besides a high number of monoenergetic spectra additional informations will be used from the experimental spectra. The unfolding of pulse height distributions shows, that these inversing methods are well suitable to work up continuous energy distributions, even if these spectra are superimposed by a discrete line spectrum. Also the unfolding of spectra with several lines which have a sufficiently high distance in energy each from the other is possible with a sufficient accuracy in many cases. (auth)

29560 COUNTER TELESCOPE TO INVESTIGATE (n,α) REACTIONS. Brendle, M.; Moerike, M.; Staudt, G.; Steidle, G. (Univ., Tuebingen, Ger.). Nucl. Instrum. Methods; 81: 141-8 (1970).

The mechanical and electronic design of a counter telescope consisting of two gas proportional counters and a semiconductor detector is presented. Its characteristics are investigated with regard to angular, energy, energy loss, and time resolution. The telescope is tested in two parametric analysis by some neutron induced reactions. As an example the energy spectrum of the emitted α-particles from the reaction $^{16}O(n, \alpha)^{13}C$ with E_n = 13.9 MeV at an angle of 0° is given. (auth)

29561 SELF-TRIGGERING STREAMER CHAMBER AND ITS APPLICATIONS TO NUCLEAR PHYSICS. Kobayashi, S.; Itoh, H.; Yasumi, S. (Kyoto Univ.). Nucl. Instrum. Methods; 81: 72-6 (1970).

A self-triggering streamer chamber has been constructed, which is operated by the triggering of pulses due to gas scintillation following the passage of charged particles in the gas of the chamber. This type of detector seems to be one of the promising track detectors fitted for low energy nuclear physics. A gas mixture consisting of Ne(99.5%) + N_2(0.5%) was found to be suitable for the operation of the chamber. Successful operation of the self-triggering streamer chamber has been demonstrated by using a weak polonium α source. Some experiments on nuclear reactions which might easily be performed with this apparatus are suggested. (auth)

29562 LIQUID SCINTILLATION COUNTING: DATA ANALYSIS AND COMPUTERS. Carroll, C. O.; Houser, T. J. (Nuclear-Chicago Corp., Des Plaines, Ill.). Int. J. Appl. Radiat. Isotop.; 21: 261-9(May 1970).

The analysis of data from liquid scintillation counting by the channels ratio method is examined and the desirability of doing a statistical analysis of the data in order to ensure its reliability is shown. The often neglected problem of choosing the proper calibration curve is examined in detail and a discussion of the uncertainties in the final results is given. Finally, an outline of three computer programs for singly labeled and dual-labeled counting is presented. (auth) (UK)

29563 TIME-MODE OPERATION OF A MOESSBAUER SPECTROMETER WITHOUT PRECISION CONTROL OF THE DRIVE WAVEFORM. Preston, R. S.; McDowell, W. P. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 81: 285-90(1970).

A new method has been developed for storing a Moessbauer spectrum in a multichannel analyzer. The method combines the high counting-rate capability of conventional time-mode operation with the undistorted velocity scale characteristic of operation in the pulseheight mode. Nonlinearity and instability of the drive waveform can be tolerated because a normalization spectrum for eliminating vertical distortions can be obtained concurrently with the Moessbauer spectrum. This normalization spectrum costs practically nothing in counting time or counting statistics, but storage space must be available for it in the analyzer. The necessity for a normalization spectrum can be eliminated by a simple modification of the method, but at the cost of a slight nonlinearity of the velocity scale. (auth)

29564 THEORY OF POLARIZATION SPECTROMETERS FOR THERMAL NEUTRONS. Misenta, R. (EURATOM–Joint Nuclear Research Center, Ispra, Italy). Nucl. Instrum. Methods; 81: 317-24(1970).

The theory of a polarization spectrometer for thermal neutrons is described. Relations for the errors which are caused in the separated intensities of the two spin states by deviations of the spectrometer properties from the ideal values are derived. The results of calculations of the separation errors are presented for different sets of values of the spectrometer properties. (auth)

29565 STATISTICAL CONSIDERATIONS IN HALF-LIFE MEASUREMENT. II. Jaffey, A. H. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 81: 253-62(1970).

This paper is a continuation of an earlier one in which certain factors affecting the statistical error and systematic error (bias) in half-life estimation are examined from a statistical viewpoint. In this paper, we consider: (1) the effect of not using the mean time-value in a counting interval, (2) the effect of the logarithmic transformation in least-squares curve-fitting, (3) the effect of using measured counting rates for weights, and (4) the effect of random errors in time measurement. In this analysis, there is a detailed discussion of the least-squares curve-fitting method for estimating a single half-life. (auth)

High Energy Physics Instrumentation

Refer also to abstract 30439.

29566 (KFKI-70-8-HEP) METHOD FOR DETERMINATION OF NEUTRAL DECAY POINTS WITHOUT TRACK RECONSTRUC-

TION IN SPACE. Nagy, E.; Teibisz, F.; Vesztergombi, G. (Magyar Tudomanyos Akademia Kosponti Fizikai Kutato Intezete, Budapest). 31 Mar 1970. 5p. Dep. CFSTI (U. S. Sales Only).

A FORTRAN program for the ICT 1905 computer for estimating a physical parameter from bubble chamber particle tracks using immediately the coordinates measured on three stereoviews (without track reconstruction) is briefly described. The program consists of two parts which are the geometrical preparation program and the decay point fitting program. This program is being used to find the best coordinates of the decay point of the $K^0 \rightarrow 2\pi^0$ decay. (W.H.K.)

29567 (NAL-tr-1) DIFFERENTIAL-THRESHOLD CERENKOV COUNTER. Prokoshkin, Yu. D. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated for National Accelerator Lab., Batavia, Ill., from Russian report IHEP-69-7. 9p. Dep. CFSTI.

The differential threshold counter, which is a modification of the Cherenkov counter, is described. This differential threshold counter combines high resolution with a large angular aperture and is a Cherenkov threshold counter in which the output pulses of the photomultiplier are discriminated in a narrow band and only those pulses are counted which correspond to the knockout of a small number of photoelectrons from the photomultiplier photocathode. The pulse height spectra for various gas pressures and the corresponding different mean values of the number of photoelectrons are calculated. The counter efficiency and pressure curves are also shown. (J.F.P.)

29568 (NAL-tr-2) HIGH RESOLUTION CERENKOV COUNTER. Gorin, Yu. P.; Denisov, S. P.; Donskov, S. V.; Junaitsev, A. F.; Petrukhin, A. I.; Prokoshkin, Yu. P.; Stoyanova, D. A.; Shuvalov, R. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated for National Accelerator Lab., Batavia, Ill., from Russian report IHEP-69-63. 16p. Dep. CFSTI.

A gas Cherenkov threshold counter with a velocity resolution $\delta = 6.5\ (10)^{-6}$ and 5 m in length is described. A resolution of $\delta = 3.6\ (10)^{-6}$ was achieved as the result of summarizing the signals from two counters. High velocity resolution was obtained due to the effective registration of Cherenkov light in the short-wave region (counter spectral range is 180 to 600 nm). The threshold counter characteristics were investigated on 5 to 60 GeV/c beams of the 70-GeV accelerator. The particle registration efficiency on the plateau is more than 99.99994%. The probability of the particle registration below the Cherenkov radiation threshold is less than $3(10)^{-4}$. (auth)

29569 (SJC-T-70-1) AUTOMATIC ANALYSIS OF SPARK-CHAMBER PHOTOGRAPHS. II. Kiyoshima, T.; Yamagata, Taketora (Tokyo Univ. (Japan). Inst. for Nuclear Study). Jan 1970. 91p. (In Japanese and English). Dep. CFSTI (U. S. Sales Only).

An automatic scanning system for spark chamber films has been constructed and a program system for its operation and the subsequent analysis has been developed. The latter consists of MAGREC (automatic scanning), MAGCAL (spatial reconstruction and kinematical calculation), and SUMMARY (statistical processing). It was used for analyzing 150,000 pictures, with a success rate of 82%. It took 0.8 sec per event for MAGREC and 0.5 sec for MAGCAL. The precision of the measurement and the propagation of its error have been treated. (auth)

29570 A SIMPLE STRIPLINE PULSER FOR SPARK CHAMBERS. Howells, M. R.; Osmon, P. E.; Sheldon, A. G. (Westfield Coll., London). Nucl. Instrum. Methods; 79: 325-8(1970).

A spark chamber pulser has been constructed using a stripline as both feeder cable and storage capacitor. The inductance of the unit is thereby minimized in a simple and inexpensive way and a pulse rise time of 10 ns into a 1000 pF load is achieved. (auth)

29571 INFLUENCE OF TRANSMISSION-LINE BEHAVIOUR OF SPARK CHAMBERS ON MULTI-TRACK EFFICIENCY. Allkofer, O. C.; Grupen, C.; Maxion, G. (Univ., Kiel). Nucl. Instrum. Methods; 79: 181-91(1970).

Spark chamber properties can be understood if transmission-line characteristics are taken into account. The theoretical calculations presented, especially concerning multi-track efficiency, are in reasonable agreement with experimentally obtained results. (auth)

29572 PERFORMANCE OF A SYSTEM OF PROPORTIONAL WIRE CHAMBERS. Bemporad, C. (CERN, Geneva); Beusch, W.; Melissinos, A. C.; Schuller, E.; Astbury, P.; Lee, J. G. Nucl. Instrum. Methods; 80: 205-12(1970).

Results obtained by operating a system of proportional wire chambers in a high-energy (9–16 GeV/c) beam in conjunction with a diffraction dissociation experiment are reported. Single and multitrack efficiency is better than 99%, and firing of two adjacent wires is of the order of 10%. Space resolution is of the order of one-quarter the wire spacing, as expected. Time resolutions of 150 nsec were achieved, and the deadtime is of the order of 250 nsec per wire. (auth)

29573 LOW COST AMPLIFIER/DISCRIMINATOR/LIMITER FOR PROPORTIONAL MODE WIRE CHAMBERS. Simanton, J. R.; Bourkland, K. R.; Marquardt, R. F. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 81: 13-21(1970).

A low cost, compact, and versatile circuit utilizes commercial integrated circuits with peripheral passive components to amplify, discriminate and limit signals from proportional mode wire chambers. Designed to duplicate input/output characteristics within ±5% without adjustment or component selection, the circuits have been successfully used in a design facility to evaluate wire chamber performance on-line to a computer. Large numbers of circuits may be ganged for precision remote discrimination level adjustment. Recovery from large overloads is instantaneous. The circuit is described, with its performance illustrated and discussed for various applications. (auth)

29574 ACCURATE POSITION DETERMINATION OF PARTICLE TRAJECTORIES USING PLASTIC SCINTILLATOR COUNTERS. Bollini, D.; Dalpiaz, P.; Frabetti, P. L.; Massam, T.; Navach, F.; Navarria, F. L.; Schneegans, M. A.; Zichichi, A. (CERN, Geneva. Univ., Bologna. Istituto Nationale di Fisica Nucleare, Bologna. Centre de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods; 81: 56-60(1970).

Using the CDF technique for locating charged particles in plastic scintillator counters, it has been found that the accuracy in determining the position of an incident particle in the counter is essentially a function of the distance between the two photomultipliers. Moreover it has been shown that a position resolution of $\Delta x = \pm 0.15$ cm and a time resolution of $\Delta t = \pm 0.07$ nsec can be achieved in a simple way. Finally it has been shown that it is possible to measure simultaneously the coordinates of an incident particle in two orthogonal directions. This would allow to measure particle trajectories in high rate beams, when spark chambers cannot be used. (auth)

29575 AUTOMATIC MEASUREMENT OF BUBBLE CHAMBER NEGATIVES. Bloch, Michel (College de France, Paris). Nucleus (Paris); 10: 373-81(1969). (In French).

A discussion is given on how to measure bubble chamber film negatives without loss of information, that is, conserving all the precision of the bubble chamber. The specifications imposed by the physics of the bubble chamber, the HPD system for automatic measurements, and the performance of the machine are considered. (J.F.P.)

29576 A MEASUREMENT OF THE ANALYSING POWER OF ALUMINIUM FOR 490 MeV PROTONS. Dowell, J. D.; Grayer, G. H.; McMahon, T. J.; Ruddick, K.; Eaton, G. H. (Univ. of Birmingham, Eng.). Lett. Nuovo Cim.; 3: 614-17 (2 May 1970).

A report is presented of the measurements of the analysing power for proton-aluminum scattering over the range 2 to 20 degrees laboratory angle at a mean kinetic energy of 490 MeV. (L.W.A.)

29577 ENERGY MEASUREMENTS USING IONIZATION SPECTROMETERS. Gillespie, C. R.; Huggett, R. W.; Jones, W. V. Nucl. Instrum. Methods; 81: 270-6(1970).

The average nuclear-electromagnetic cascade development resulting from a proton of given primary energy incident on an iron absorber was determined by simulating the individual cascades from several hundred single protons incident on an ionization spectrometer using a one-dimensional model. For each simulated cascade the number of particles at various sampling layers in the absorber was found, a frequency distribution was obtained, and from this, the average number of particles as a function of absorber depth was calculated at primary energies from 10 to 1000 GeV. Using this calculation, the incident energy was determined from the total number of cascade particles detected at all of the sampling layers in the ionization spectrometer. Error determination in the measurement is discussed. (W.H.K.)

29578 OPTICAL DIGITIZATION OF WIRE SPARK CHAMBERS. Krienen, F. (CERN, Geneva). Nucl. Instrum. Methods; 81: 310-16(1970).

A new solution has been found for the operation of digitized wire spark chambers inside a magnetic field. The wire chambers have crossed wire planes and each wire is connected up to a secondary spark unit, which is located well outside the magnetic

field volume. The spark unit is a two-dimensional array of closely packed spark points. A spark is produced on those points which correspond to the position of the primary spark initiated by the charged particle trajectory, i.e., one sees two projected sparks for each primary spark. A television camera looks at this optical image. The electrical output of the camera may be processed to obtain the particle coordinates in a digitized form. (auth)

Radiation Dosimeters

Refer also to abstracts 29385–29387.

29579 (RISO-M-1238) A READER FOR THE MEASUREMENT OF SOLID THERMOLUMINESCENCE DOSIMETERS BY MEANS OF HOT NITROGEN GAS. Boetter-Jensen, L. (Danish Atomic Energy Commission, Risoe. Research Establishment). Apr 1970. 14p. Dep. CFSTI (U. S. Sales Only).

A thermoluminescence reader was designed for the measurement of solid TL dosimeters. The system is based on a hot nitrogen gas stream as the heating medium, thus providing a built-in means of reducing the non-radiation-induced TL. Other advantages of nitrogen heating over traditional heating systems are: (1) no thermal background radiation; (2) a very reproducible heating procedure as the dosimeter is completely surrounded by the heating medium; and (3) a very convenient dosimeter feeding procedure. The system incorporates facilities for automatic print-out of the results on a teletype printer and punched tape for data processing in a computer. The TL-reader has shown excellent stability and is distinguished by extreme sensitivity. (auth)

29580 (UCRL-18793, pp 89-91) RADIATION DOSIMETRY USING MINIATURE SILICON DIODES. Raju, Mudundi R. (California Univ., Berkeley. Lawrence Radiation Lab.).

Characteristics of miniature silicon diodes for dosimetry are discussed including radiation damage, dose-rate effects, temperature effects, directional response, and energy response. The sensitivity is about the same for cobalt-60 gamma rays, 8-MeV electrons, and high-energy x rays. (W.D.K.)

29581 ACCIDENT DOSIMETRY BY THERMOLUMINESCENCE OF FELDSPAR. Ichikawa, Yoneta (Nara Univ., Japan); Fukuda, Shigetoshi; Higashimura, Takenobu. Bull. Inst. Chem. Res., Kyoto Univ.; 48: 40-4(Jan 1970).

Several crystals of natural feldspar were surveyed for the purpose of accident dosimetry by thermoluminescence. The glow curves resulting from the samples showed glow peaks at about 140, 170, and 230°C. It has been found that the 140°C peak is the most desirable one from a view-point of accident dosimetry. The natural glow intensity and sensitivity were examined over some microcline samples for this peak. Moreover, the variations of glow curve with the ^{60}Co gamma-ray doses were observed on the two samples and it was assured that the 140°C peak had the advantage of excellent linearity for the absorbed dose to 5×10^4r at least. (auth)

29582 NUMERICAL METHOD FOR THE ANALYSIS OF FILM BADGES. Cavallini, A. (CNEN, Casaccia, Italy); Fioroni, F.; Paretti, C.; Prodi, V.; Ricci, A. Ing. Nucl.; 10: No. 4, 6-9(Jul-Aug 1969). (In Italian).

The present study illustrates a method of classification and identification of the rectilinear structure contained in a plane image, applied to a problem of automation of the analysis of dosimetric films for fast neutrons. The method is based on a numerical-type development, and the efficiency was verified by computer simulation. (tr-auth)

29583 FERROUS SULFATE MINI-DOSIMETER. Kartha, Mukund (Ohio State Univ., Columbus). Radiat. Res.; 42: 220-31(May 1970).

With the increased application of high-energy radiation beams in therapy, the use of chemical dosimetry has become very extensive. The conventional measurement technique limits the minimum measurable dose to 4 krads, within a standard deviation of 1%. In order to calibrate the electron and photon output of a 35-MeV therapeutic betatron, we have developed a dosimetric technique by which doses as small as 250 rads can be measured with a standard deviation of 1%. Specially designed 5- and 10-cm path length microcells were used to measure the absorbance of the irradiated solution at 224-nm absorption peak. Since the volume of the dosimetric solution used is less than 0.5 ml, this technique has the advantage of measuring doses more representative of that at a point. In the course of this investigation we have observed that the use of polystyrene irradiation containers increased the standard deviation of measurement to 3%. However, when thin-walled Pyrex containers were used, the standard deviation was 1%. (auth)

29584 PROTON DOSIMETRY: MEASUREMENT OF DEPTH DOSES FROM 185-MeV PROTONS BY MEANS OF THERMOLUMINESCENT LiF. Carlsson, Carl A.; Carlsson, Gudrun Alm. (Univ. of Lund, Sweden. Uppsala Univ.). Radiat. Res.; 42: 207-19(May 1970).

An analysis is made of the correction factors involved when a detector is used for depth-dose measurements. The detector signal has to be corrected for (1) variations with depth of the relative energy absorption in detector and medium; and (2) variations with depth of the sensitivity of the detector. The sensitivity is defined as the signal per unit absorbed dose in the detector. In particular, the performance of thermoluminescent LiF for depth-dose measurements with high-energy protons (185 MeV) in a water phantom has been studied. The sensitivity of LiF as a function of phantom depth was studied by comparing the signals from a LiF dosimeter and a nitrogen-filled ionization chamber obtained at different phantom depths. The performance of the LiF dosimeter, relative to that of the ionization chamber and the Fricke dosimeter, is discussed. (auth)

29585 . QUARTZ AS A HEAT-RESISTANT DOSIMETER. Fleming, S. J.; Thompson, J. (Oxford Univ.). Health Physics.; 18: 567-8(May 1970).

Radiation dose may be measured by means of the increase which it produces in the thermoluminescence sensitivity of quartz. The measurement is possible even if the quartz is heated after the dose is received (for example, for several hours at temperatures up to 300°C). This makes the quartz suitable as a heat-resistant dosimeter. (auth) (UK)

29586 DOSIMETRY USING OPTICAL DENSITY CHANGES IN LiF. Vaughn, W. J.; Miller, L. O. (Naval Radiological Defence Lab., San Francisco). (Health Phys.; 18: 578(May 1970).

A suggestion has been made that the optical band changes associated with the coloration changes produced by exposure of LiF crystals to ionizing radiation might be useful in dosimetry (Nakajima, T. Jap. J. Appl. Phys. 7, 1418(1968)). The investigation reported has correlated optical density changes in the R, M and N_2 bands of LiF with dose. The findings are that these three bands can be used to monitor exposures between 10^6 and 2×10^8R. (UK)

29587 A THERMOLUMINESCENT PERSONNEL NEUTRON DOSIMETER. Korba, A.; Hoy, J. E. (E. I. Du Pont de Nemours and Co., Aiken, S. C.). Health Phys.; 18: 581-4(May 1970).

Attempts to develop energy-independent neutron dosimeters insensitive to gamma radiation have been unsuccessful. Using a particular arrangement of moderators and absorbers, a thermoluminescent personnel neutron dosimeter has been developed which measures neutron dose equivalent and which is relatively independent of spectral distribution. This thermoluminescent dosimeter has a lower detection limit of 5 mrem, is dose rate independent, can be used in radiation fields having photon-to-neutron dose ratios up to 100:1, exhibits negligible fading, and can be read by conventional readout systems. (auth) (UK)

29588 ON THE FLUORESCENCE DECAY OF SILVER-ACTIVATED GLASS DOSIMETERS. Barthe, Jean (Centre de Physique Atomique et Nucleaire, Toulouse); Blanc, Daniel; Commanay, Louis; Teyssier, Jean; Francois, Henry. Health Phys.; 18: 575-7(May 1970).

A systematic study of the radiophotoluminescence decay of various glasses made in France and Japan has been carried out. The experimental equipment is described. The curve of the fluorescence decay as a function of time is represented by the sum of three constants. $I(t) = A_1 \exp - t/\gamma_1 + A_2 \exp - t/\gamma_2 + A_3 \exp - t/\gamma_3$. Tables are given of the measured time constants (γ_1, γ_2, γ_3) as functions of irradiation dose for different glasses (UK)

29589 NOTES ON THE PHOTOGRAPHIC-FILM DOSIMETRY OF FAST NEUTRONS. Medveczky, L.; Bornemisza-Pauspertl, P. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 28: 217-24(1970).

Kodak Fast Neutron Monitoring Films of different ages were irradiated for calibration with fast neutrons of the reactions (D + D) and (D + T). The energy distributions of the neutrons were also measured using Ilford K2 nuclear plates irradiated simultaneously. According to the results, the density of the tracks containing less than five grains is independent of the dose over a wide range; the track-counting was performed with an accuracy of ±20% under a realistic scanning time; aging tendency was not observed. (auth)

29590 IONIZATION CHAMBER FOR MEASURING DOSE RATES UP TO 10^4 ROENTGENS PER SECOND. Mukhachev, B. V.; Rudakova, G. M.; Samoylov, P. S. Tr. Soyuznogo Nauch.-Issled. Inst. Priborostr.; No. 10, 12-16(1969). (In Russian).

An aluminum thimble chamber is described which is designed for measuring the exposure dose rate of gamma radiation up to 10,000 R per second. The high-voltage and collecting electrodes in the chamber take the form of cylinders which change into a hemisphere. In two modifications of the chamber, the working gap is 2.0 and 3.5 mm (the working volume of the chamber is 4.3 and 8.2 cc respectively). The setting insulators are made from a radiation resistant ceramic—SK-1 stearite with a radiation reserve of 10^{11} Rads. The working voltage across the chamber is 500 V. The sensitivity of the chamber is studied as a function of temperature. A change in temperature from 20 to 80°C caused a reduction in chamber sensitivity by ≈15%. (auth)

Radiometric Instruments

29591 (NYO-4069-1) KRYPTONATE-BASED INSTRUMENTATION DEVELOPMENT FOR AUTOMOBILE EXHAUST POLLUTANTS. Phase I Report: Feasibility. Goodman, Philip; Donaghue, Thomas (Panametrics, Inc., Waltham, Mass.). Mar 1970. Contract AT(30-1)-4069. 41p. Dep. CFSTI.

The technical feasibility has been found for detecting pollutants present in automobile exhausts at concentrations below the projected standards for 1975. In a laboratory test system, a concentration of 125 ppM CO was detected by a $PdCl_2$ kryptonate sensor, and 2 ppM NO_x was detected by a hydroquinone clathrate sensor. A PtO_2 kryptonate sensor detected 13 ppM C_3H_8 and was sensitive to hydrocarbon molecular weight. Interferences were absent. A survey of available instruments and of requirements for automobile exhaust pollutant monitoring showed that a need exists for an instrument with the capabilities envisaged for a kryptonate-based instrument. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 29388, 29809, 30036, 30768, and 31097.

29592 (AI-AEC-12959) LMFBR TASK 25, TRANSIT TIME FLOWMETER. Quarterly Technical Progress Report, January–March 1970. (Atomics International, Canoga Park, Calif.). 15 May 1970. Contract AT(04-3)-701. 8p. Dep. CFSTI.

The development of a liquid metal flowmeter using cross-correlation techniques is summarized. Small temperature variations (thermal eddies) are detected at two points in the flow stream and the two signals are cross-correlated with a variable delay time. The delay time which gives maximum correlation is the transit time of the fluid between the sensors. (W.H.K.)

29593 (JUL-635-RG) TEMPERATURE MEASUREMENT BY THERMAL NOISE (AN ABSOLUTE THERMOMETER FOR HIGH TEMPERATURE). Brixy, Heinz G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Jan 1970. 57p. (In German). Dep. CFSTI (U. S. Sales Only).

The Nyquist formula is used for determining the temperature. The noise voltages of two resistors are compared, one at the unknown temperature, the other at room temperature. The ratio of the resistances, when the noise voltages from the two resistors are equal, determines the ratio of their absolute temperatures. Several temperatures are measured in the range from 300°K to 1100°K with an accuracy of better than 0.2 percent. The noise thermometer is independent of the material from which it is made or its previous thermal and mechanical treatment. It is also independent of the environment like nuclear radiation and therefore especially suitable for temperature measurement in nuclear reactors. (auth)

29594 (LA-4278) COLOR FILM OUTPUT FROM COMPUTER RUNS. Berry, F. G.; Buckner, D. C.; Crook, R. C.; Dickman, D. O. (Los Alamos Scientific Lab., N. Mex.). Jan 1970. Contract W-7405-eng-36. 21p. Dep. CFSTI.

Research and development progress for producing 35- and 16-mm color film output from the CDC 6600 computers is described. Advantages of color film output from computer runs, SC-4020 hardware modifications including a new color filter device, and color film processing are discussed. (W.H.K.)

29595 (NYO-3906-10) ULTRASONIC THERMOMETRY IN LMFBR SYSTEMS. Progress Report Covering the Quarter Ending March 1970. Papadakis, E. P.; Patch, D. R.; Lynnworth, L. C.; Carnevale, E. H. (Panametrics, Inc., Waltham, Mass.). Apr 1970. Contract AT(30-1)-3906. 8p. Dep. CFSTI.

The development of an ultrasonic system to measure temperature in the coolant, cladding, and fuel of liquid metal-cooled fast breeder reactors is described. The status of the BSR test of gamma radiation effects on a magnetostrictive transducer at high temperature and the status of the Oak Ridge Thermocouple Test are summarized. Also, development of an ultrasonic temperature sensor at the FFTF is outlined. (W.H.K.)

29596 (SLAC-PUB-750) A NEW PRECISION MEASUREMENT SYSTEM FOR BEAM TRANSPORT TYPE MAGNETS. Cobb, J. K.; Horelick, D. (Stanford Linear Accelerator Center, Calif.). May 1970. 14p. (CONF-700503-2). Dep. CFSTI.

From 3rd International Conference on Magnet Technology, Hamburg, Germany.

The applicability of magnetic spectroscopy to the general measurement of magnets, particularly beam transport magnets, is discussed. It is shown that the multipole strengths available from spectroscopy can be used directly in beam transport equations. Several systems for instrumenting magnetic spectroscopy are described. First, the conventional wave analyzer which is limited in accuracy and difficult to automate. Second, an incremental integrating approach which is appropriate for off-line Fourier analysis by computer; this approach has been tested. Last, a proposed on-line computer system is detailed which has the additional capabilities for on-line data processing and closed-loop current control. Such a system has flexibility and potential considerably beyond those of the other systems. (auth)

29597 (ZJE-70) THE DEVELOPMENT OF CALORIMETRY IN THE SKODA NUCLEAR POWER PLANTS DIVISION. Kott, J. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 7p. Dep. CFSTI (U. S. Sales Only).

The development of calorimeters in the SKODA Nuclear Power Plants Division, their different types according to their usability, and the measurements made on different reactors both in Czechoslovakia and abroad are described. (auth)

29598 DESIGN OF CHARGE PREAMPLIFIER FOR HIGH COUNTING RATES. Lefevre, G.; Griot, D.; Flamant, Y.; Salmer, G. (Institut d'Etudes Nucleaires, Alger, Algeria). Nucl. Instrum. Methods; 79: 219-23(1970). (In French).

To preserve a good resolution at high counting rates we studied and realized a charge-sensitive preamplifier (P.A.C.) operating at up to 300,000 counts per second. Then, we observed in which conditions it was possible to change a conventional P.A.C. without failure of its intrinsic resolution. (auth)

29599 MEASUREMENT OF MAGNETIC FIELD CONSTANTS BY A MODIFIED METHOD OF OPTICAL ORIENTATION OF ATOMS. Grinko, I. E.; Skripkin, A. M. Opt. Spectrosc. (USSR) (Engl. Transl.); 27: 463-4(Nov 1969).

Translated from Opt. Spektrosk.; 27: 850-2(Nov 1969).

A method and an apparatus are described for measuring small magnetic fields using the dependence of the transverse components M_x and M_y of the total magnetic moment of optically oriented ^{87}Rb atoms on the transverse magnetic fields for an amplitude-modulated magnetic field in the direction of the orienting light beam. The apparatus measures the field constants inside multilayer permalloy screens, with automatic compensation of these fields along the two components H_x and H_y. The experimental sensitivity was found to be 10^{-7} Oe. (auth)

29600 THE USE OF INTEGRATED CIRCUIT AMPLIFIERS TO PROVIDE VARIABLE BIAS IN SINGLE-CHANNEL PULSE-HEIGHT ANALYSERS. Cole, H. A. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 79: 356-8(1970).

An arrangement of integrated circuits is described which enables a single-channel pulse-height analyser to operate with symmetric or asymmetric channel width, or as two independent discriminators sharing a common input terminal. (auth)

29601 LONG PERIOD TIME-TO-PULSE HEIGHT CONVERTER AND NEW CALIBRATION METHODS. Glatz, J. (Univ., Freiburg i. B. Technische Hochschule, Munich). Nucl. Instrum. Methods; 79: 277-82(1970).

A time-to-pulse height converter (TPC) suitable for the measurement of nuclear half-lives in the range of microseconds to seconds is described. The apparatus, based on an oscilloscope sweep unit, is capable of converting the time delays of all pulses accepted within the selectable fixed conversion period. The differential conversion linearity obtained is better than 1.5%. Versatile methods of high accuracy are proposed for pulse delay measurements and TPC calibration covering the region of about 10^{-7}s to 1s. Corrections of experimental time spectra due to multichannel analyzer deadtimes are discussed in detail. (auth)

29602 CONTRIBUTION TO A BETTER VISIBILITY OF SCINTIGRAPHIC IMAGES. Loeb, J. (Bureau d'Etudes Techni-

ques, Strasbourg). J. Biol. Med. Nucl.; 3: No. 12, 19-22(1968). (In French).

The result of a scintigraphic analysis can be shown simultaneously by colored or noncolored tappings or by photography. Photos are more informative since they give more details and also to a certain degree a tridimensional view. In spite of these advantages they are used less in clinical practice. For this reason an attempt was made to bring scintigraphic reproduction by tapping up to the photographic level. This could be done in a simple way by coupling the tapping apparatus with an interrupting device. The principle of the action of the interruptor is shown graphically by comparison of the ictometric response to a classical tap line with that to an adjusted tap line. In the former one stroke corresponds to a certain number of counts and will give a general image of the activity, though not one the details of which can easily be grasped by the human eye. In the latter the tapping rhythm is adjusted electronically to variable values which are obtained by comparison of the cumulative counts with the complement of the medium count of the visualized area. The advantage of the adjusted taps consists in better contrasts which is of particular significance, if the number of taps is of high frequency, while the count variation is small. In such cases the classical technique eliminates information due to low activity, when background noise or residual activity of the patient is high. This, however, will not be the case in the proposed technique, where the precount value will be high, if the mean value of counts is low and vice versa. Principle and assembly of the new tapping device are shown in block diagrams. (F.J.W.)

29603 AUTOMATIC MULTIPARAMETRIC TIME OR PROGRAM CONTROLLED DATA TAKING AND SIGNAL ENHANCING BY USE OF A MULTICHANNEL ANALYZER. Farr, W.; Otten, E. W. (Univ., Heidelberg). Nucl. Instrum. Methods; 80: 284-90(1970).

A measuring method is described which allows simultaneous multiparametric data taking of weak signals buried in noise and high background signals. Applications to experiments in atomic and nuclear physics are described. The system consists of an ordinary multichannel analyzer and a buffer counting system connected with a relatively simple interface, so that the disadvantages of multiplexers and routing the addresses are avoided. In addition, program controlled experiments can be performed by using free parts of the analyzer's memory as a program register. Therefore this system allows for on-line computer-like experiments—without simultaneous computation, however—but with the advantage of being less expensive and complicated than an on-line computer. (auth)

29604 DIGITAL PROGRAMMABLE TIMING SYSTEM WITH CRYSTAL CONTROLLED PARAMETERS. Besch, H. J.; Farr, W.; Otten, E. W. (Univ., Heidelberg). Nucl. Instrum. Methods; 80: 277-83(1970).

A modular timing system, the parameters of which can be programmed in a large range (10^{-7}–10^{3} sec) of binary crystal controlled steps, and its application to physical experiments are described. (auth)

29605 HIGH-WATTAGE TWIN WATER FLOW CALORIMETER. Fellers, C. L.; Nutter, J. D. (Monsanto Research Corp., Miamisburg, Ohio). Contract AT(33-1)-GEN-53. Nucl. Instrum. Methods; 80: 192-6(1970).

A differential twin flow calorimeter has been developed with an unusually large measuring range of 20 to 2 000 W. The calorimeter does not require a controlled environment for operation and possesses the unique features of adjustable sensitivity and time constant. The standard deviation of 20 measurements made on a 550-W heat standard was less than 0.3% of the actual value. (auth)

29606 THREE-AXIS GONIOMETER FOR CHANNELLING EXPERIMENTS. Knox, K. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 81: 202-4 (1970).

The design of a precision three-axis goniometer suitable for remote operation inside a vacuum chamber is described. Such an instrument has been successfully employed in ion channeling experiments at Harwell for several years. The stepping accuracy and backlash are better than 0.02°. (auth)

29607 X-RAY IMAGE DISSECTION USING A CHANNEL MULTIPLIER ARRAY. Gott, R.; Parkes, W.; Pounds, K. A. (Univ. of Leicester, Eng.). Nucl. Instrum. Methods; 81: 152-4(1970).

A method of one dimensional X-ray image dissection has been developed using a channel multiplier array and giving a spatial resolution of better than 0.2 mm. Electron pulses are collected from the array on a grid of evenly spaced wires which are capacitatively coupled; positional information is then obtainable by comparison of the pulses from each end of the condenser chain. (auth)

29608 FAST TIMING CIRCUIT USING CHARGE STORAGE DIODE. Ondris, L.; Richvickii, S. V.; Semenyushkyn, I. N.; Horvath, P.; Khrenov, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 81: 121-4(1970).

A fast timing circuit with time shift compensation, based on the charge storage effect in semiconductor diodes, is described. Within the dynamic amplitude range 0.09–10 V an output pulse time shift smaller than ±140 ps has been achieved with a light pulse generator. In the 5 GeV π^--meson beam with a 25 × 25 × 25 mm plastic scintillator and a XP 1020 photomultiplier time resolution of 0.33 ns has been measured. (auth)

29609 PRELIMINARY REPORT OF AN IMPROVED TECHNIQUE FOR DETERMINING MEAN RANGE OF ALPHA PARTICLES IN WATER. Moss, C. E. (Virginia Commonwealth Univ., Richmond). Nucl. Instrum. Methods; 81: 327-8(1970).

A new technique which uses the concepts of a simple light interferometer and scintillation spectrometer is discussed for determining the mean range of alpha particles in water. (auth)

29610 FAST LIMITER AND TRIGGER CIRCUIT WITH LOW SLEWING AND NO DEAD-TIME OUTPUT. Looten, A. (CERN, Geneva). Nucl. Instrum. Methods; 81: 325-6(1970).

A simple method is described here to improve time resolution of triggers and limiters commonly used in nuclear physics. For amplitude variation of 15/1 of 2 nsec signals, at input rate of 160 MHz, and sensitivity of 600 mV, a walking of 125 psec is achieved. (auth)

29611 PARTICLE IDENTIFICATION WITH A PDP-7 COMPUTER IN ON-LINE OPERATION. Emmerich, W.-D.; Elzer, P.; Hofmann, A. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods; 81: 277-9(1970). (In German).

An analysis and evaluation program system was developed for on-line particle identification using a PDP-7 computer. The system was successfully used for investigations of deuteron scattering and other nuclear reactions. (auth)

29612 IMAGE INTENSIFIER. Tsushima, Itsuro (Yamanashi Univ., Kofu, Japan). Uchusen Kenkyu; 14: 273-80(Oct 1969). (In Japanese).

The development of an image tube in Japan is reviewed. The performance of representative tubes in the world including the Toshiba M7064 is tabulated. The application of image tubes to physical research, such as high-speed cameras, streamer chambers, astronomical spectroscopy, track detectors, Cherenkov rings, air showers, and calorimeter measurements is discussed. The use of image intensifier for the ECC apparatus is now planned at the Institute for Nuclear Study, and preliminary measurement has been performed for one year. The use of image intensifier has the following advantages: (i) easy triggering, (ii) high spatial resolution, (iii) large-area apparatus, and (iv) low cost. A test experiment was planned with a small-scale apparatus. The results of the preliminary experiment are briefly reported. (NSA of Japan)

29613 MODULE SYSTEM FOR RADIATION MEASURING INSTRUMENTS. Kinbara, Setsuro (Japan Atomic Energy Research Inst., Tokai). Radioisotopes (Tokyo); 18: 578-85(Dec 1969). (In Japanese).

The module system made its debut with the advance of measurement and technology, and is making rapid progress by standardization. Its features are interchangeability and versatility, and the system is now a very common form of the instruments for radiation measurement. The kinds of standard are tending to converge into the NIM system as the central one. The development so far has been for the modules of analog type, but in the future those of digital type will be studied with the advance of computers and their utilization. Topics include: background for the evolution of the module system; the types of module systems and the trend (British 2000 series, Euratom's ESONE (RENATRAN and IANUS), and U.S.'s NIM) and the state of their uses in different countries; the outline of NIM Standard with 8¾ in. height; the features and application of the module system, interchangeability, versatility, etc., and the treatment of analog signal, digital data, etc.; and the future of module systems. (NSA of Japan)

Radiation Effects on Instruments and Instrument Components

29614 (N-70-20409) INVESTIGATION OF THE EFFECTS OF SUB-THRESHOLD HIGH-ENERGY ELECTRONS ON THE

PROPERTIES OF SILICON PHOTOVOLTAIC CELLS. Midway Report, February 3–August 3, 1969. Loferski, J. J.; Crisman, E. E. (Brown Univ., Providence, R. I. Div. of Engineering). Sep 1969. Contract NAS7-100. 23p. (NASA-CR-108906). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

The effects of irradiating semiconductors by sub-threshold electrons is reviewed. It is pointed out that lithium atoms dissolved in silicon would be displaced by electrons whose energy is less than 35 keV, whereas the electron must have about 150 keV to displace a silicon atom. Experiments designed to test this phenomenon are described. The effects of electron irradiation on semiconductor surfaces are also reviewed. Experimental apparatus for investigation of the effects of electron irradiation in organic vapor-free vacua (like those of outer space) on the characteristics of silicon photovoltaic cells is described. (auth) (STAR)

29615 (N-70-20650) RADIATION KINETICS IN ELECTRONIC MATERIALS. Semiannual Report. Sosin, Abraham (Utah Univ., Salt Lake City. Dept. of Physics). 15 Dec 1969. Contracts NAS7-100; JPL-952384. 7p. (NASA-CR-108995). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

The formulation, structuring, and solution of models for degradation, recovery, and redegradation of minority carriers in solar cells are studied. The spontaneous and full recovery of lithium in irradiated solar cells is discussed. In developing computer-based reaction kinetics for the diffusional aspects in solar cell damage and recovery, the main parameters are considered to be the concentrations of lithium, oxygen, vacancies, and other radiation-induced electrical centers, and the electronic state of each of these reactants is treated separately: Li vs Li(+), V vs V(–), plus the inclusion of hole and electron concentrations. (STAR)

29616 DEVELOPMENT OF RF ATTENUATOR UTILIZING FERRITE–CERAMIC COMPONENTS AND THE EFFECT OF NUCLEAR RADIATION ON THESE COMPONENTS. Adelman, Stanley M.; Willoughby, Nancy B. (Artillery Ammunition Lab., Picatinny Arsenal, Md.). pp 4.8.1-12 of Proceedings of the Sixth Symposium on Electroexplosive Devices, Held in San Francisco, Calif., July 8–10, 1969. Philadelphia; Franklin Inst. Research Labs. (1969).

See CONF-690720.

Radiation effects on ferroelectrics used in RF attenuators were investigated. The effects of interest were magnitude of voltage generated and energy transferred under various levels of radiation. Results indicate the possibility of increasing low frequency permeability of Mn–Zn ferrites under irradiation. The overall results indicate the need for developing a program to determine not only the nature and magnitude of these effects but the mechanisms by which they occur. (J.R.D.)

29617 IRRADIATION EFFECTS ON MOS TRANSISTORS, ENHANCEMENT TYPE. Chisaka, Haruo; Shinomiya, Akiko; Shinozaki, Yoshiharu (Tokyo Metropolitan Isotope Research Center). Radioisotopes (Tokyo); 19: 229-34(May 1970). (In Japanese).

The effects of electron beam irradiation on p or n channel enhancement type MOS transistors, both prepared by the dry oxidation method have been investigated. The threshold voltage V_T shifts to negative side with the increase of irradiation dose. The result can be explained by the positive charges accumulated at the SiO_2–Si interface. At the doses beyond 10^{14} electrons/cm^2, however, the threshold voltage shifts to the positive side with the increase of irradiation doses. The result cannot be explained by the positive charges only. In order to explain the result satisfactorily, the idea of electron-trapping centers has been introduced. The effective length (distance from SiO_2–Si interface) over which the positive charges collect was estimated at 410 Å. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Basic Processes

Refer also to abstracts 29787, 29788, 29794, and 29814.

29618 (STI/PUB-237) IN VITRO PROCEDURES WITH RADIOISOTOPES IN MEDICINE. Proceedings Series. Proceedings of the Symposium on In Vitro Procedures with Radioisotopes in Clinical Medicine and Research, Held in Vienna, 8-12 September 1969. (International Atomic Energy Agency, Vienna (Austria)). Feb 1970. 730p. (In several languages). (CONF-690949). IAEA $20.00.

Separate abstracts were prepared on 48 papers presented at this symposium. One additional paper discusses insulin secretion in patients with diabetes. (C.H.)

For abstracts of individual papers see: 29629-29676.

29619 (UCB-34-P-113-4) RADIOTRACER STUDIES ON THE MECHANISM OF INSECTICIDAL TOXICITY. Annual Progress Report, January 25, 1969-January 1, 1970. Casida, John E. (California Univ., Berkeley. Div. of Entomology). 15 Dec 1969. Contract AT(11-1)-34. 43p. Dep. CFSTI.

Research results are reported for studies concerned with the metabolic fate, mode of action, and/or photodecomposition of pyrethroid, rotenone, synergists, carbamates, and respiratory uncouplers; binding sites for rotenone, piericidin, and ubiquinone in the respiratory chain; biochemistry of bidrin-induced teratogenesis; sensitization of the photoalteration of insecticide chemicals; metabolism of esterase inhibitors by mixed-function oxidases; and biochemical genetics of insecticide chemical resistance. The radiotracer approach was the technique used to carry out the majority of the research. Successful synthesis of ^{14}C and ^{3}H-labeled pyrethrin I and II with very high specific activity was carried out. Results are discussed briefly. A list of the 23 publications generated by the research is included (C.O.)

29620 (UCD-472-116, pp 89-92) KINETICS OF DNA POLYMERASE ACTIVITY IN TRANSFORMED LYMPHOCYTES FROM PERIPHERAL BLOOD OF BEAGLES. Huff, Sally D.; Klein, A. Kimiko; Nix, Nancy (California Univ., Davis. Radiobiology Lab.).

A cell-free assay system for DNA polymerase from PHA-stimulated mononuclear cells from peripheral blood of beagles has been defined. When extracted from 66-hr cultures, the enzyme utilizes ^{3}H-thymidine triphosphate for incorporation into DNA at the rate of 0.21 n moles/hr/million mononuclear cells (109 μg protein). (auth)

29621 CROSS REACTION IN RADIOIMMUNOASSAY BETWEEN HUMAN CHORIONIC GONADOTROPHIN AND PLASMA FROM VARIOUS SPECIES. Bagshawe, K. D.; Orr, A. H.; Edgar, Godden J. (Fulham Hospital, London). J. Endocriol.; 42: 513-18(1968).

Radioimmunological cross reactions between human chorionic gonadotrophin (HCG) and heterologous plasma and pituitary extracts from various species were examined. Where serial dilutions of a sample do not yield a curve parallel with similar dilutions of the reference standard, quantitative estimations are not possible, but relative potencies can be determined. Such relative potencies against purified heterologous gonadotrophins may be useful for the study of species whose gonadotrophins have not been purified adequately for isotopic labeling in a species specific radioimmunoassay. (Excerpta Med.)

29622 THE METABOLISM OF CALCIUM AND YTTRIUM CHELATES OF EDTA IN THE RAT. Volf, V.; Seidel, A.; Vladar. M. (Kernforschungszentrum, Karlsruhe, Ger.). Atomkernenergie; 15: 141-6(1970).

Plasma disappearance rates and organ deposition of ^{14}C and ^{88}Y were followed up until 48 hours after single intravenous injections of labeled calcium and yttrium EDTA. The data suggest an influence of the chelated metal on the distribution pattern of EDTA in blood, plasma and bones, due to an increased transport of Y-EDTA across the cellular membrane and/or to formation of ternary complexes with endogenous ligands. In vivo, Y-EDTA is markedly dissociated. The deposition of ^{14}C in the liver is dose-dependent, irrespective of the metal chelated. No such influence of dose was observed in rats with tied off kidneys. A fraction of blood activity was associated with blood corpuscles and a fraction of skeletal ^{14}C could be released as $^{14}CO_2$. The possible reasons of these findings are discussed. (auth)

29623 A NEW METHOD FOR THE DETERMINATION OF PLASMA CLEARANCE OF LABELED SUBSTANCES WITH A SINGLE INJECTION TECHNIQUE. Mombelli, L.; Conte, L.; Roncari, G. (Univ., Milan). Radiol. Med.; 55: 1090-9(Nov 1969). (In Italian).

Accurate determination of the clearance of labeled substances with a mamillar model kinetics using only the plasma concentration curve is reported. Since elaboration of the plasma curve in accordance with the mamillar model is complicated and presupposes knowledge of the kinetics of the substance under examination, such curve is formally described on the basis of a model with increasing volume. This gives a simple method for obtaining accurate determination of the clearance value, whether or not the number of compartments making up the model is known. (auth)

29624 COMPARATIVE STUDIES OF LH LEVELS IN PLASMA AND UNCONCENTRATED URINE DETERMINED BY RADIOIMMUNOASSAY AND HAEMAGGLUTINATION INHIBITION. Thomas, K.; Ferin, J. (St. Raphael's Clinic, Louvain, Belg.). Acta Endocrinol., Suppl.; No. 141, 75-83(1970).

The LH level in plasma and urine was determined by radioimmunoassay and compared with results obtained by immunochemical LH assay in urine. A significant correlation exists between LH level in plasma and urine measured radioimmunologically, and between radioimmunological and immunochemical determinations in urine. A difference in absolute values exists despite good correlation, but can be explained by the use of different standards in these two techniques. (auth)

29625 UNEQUAL ^{32}P-LABELING OF 5'NUCLEOTIDES IN RIBONUCLEIC ACIDS OF DIFFERENT MAMMALIAN TISSUES. Landin, R. M.; Moule, Y. (Institut de Recherches Scientifiques sur le Cancer, Villejuif, France). FEBS (Fed. Eur. Biochem. Soc.) Lett.; 6: 52-4(Jan 1970).

The specific radioactivities of 5'-nucleotides derived from ribosomal and transfer RNA of rat liver by phosphodiesterase hydrolysis are similar for UMP, GMP and CMP whereas that of AMP is always much higher, especially after a short time of incorporation. These facts are correlated to the very high labeling of the αP of the ATP in comparison with that of the other nucleoside triphosphates in the acid soluble precursor pool; on the other hand, the αP group of the nucleoside triphosphate is always in equilibrium with the phosphate group of the homologous nucleoside monophosphate. Similar results are obtained for 5'-nucleotides of rRNA and tRNA extracted from liver of other species such as guinea pig and rabbit. On the contrary, in rRNA extracted from rat heart and kidney and degraded by the same enzyme reaction, 5'-AMP does not show the high labeling observed in liver. An hypothesis of parallel synthesis is proposed to explain the high labeling of the αP of ATP in liver. (auth) (F.M.M.)

29626 INSULIN IN BILE: STUDIES ON THE EFFECT OF BILE ACIDS ON THE RADIOIMMUNOASSAY OF INSULIN. Jeffcoate, S. L. (Novo Research Inst., Copenhagen). Diabetologia; 4: 281-5(1968).

Bile acids in physiological concentrations interfere with the binding of insulin by anti insulin serum. The dilution curve of immunoreactive insulin in pig gall bladder bile was not parallel to that of standard pig insulin. After extraction of pig bile with anti insulin serum and assay of the extract, lower insulin levels were found. The results suggest that only a part of the immunoreactive insulin in gall bladder bile is genuine insulin. (Excerpta Med.)

29627 NEW METHOD FOR ESTIMATION OF PLASMA VOLUME WITH THE USE OF THE DISTRIBUTION SPACE OF ^{113m}In-TRANSFERRIN. Wochner, R. Dean; Adatepe, Mustafa; Van Amburg, Albert; Potchen, E. James. (Washington Univ., St. Louis). Contract AT(11-1)-1653. J. Lab. Clin. Med.; 75: 711-20(May 1970). (COO-1653-82).

Indium-113m is a conveniently produced radioisotope of a transitional metal, with a 100 minute half-life. In the current study, it was found to bind specifically to serum transferrin, in vitro and in vivo, by block electrophoresis and radioimmunoelectrophoresis. The initial plasma disappearance of ^{113m}In after intravenous administration averaged 6.1 hours in 16 subjects. Upon removal from the plasma, indium is retained in the body in unidentified tissues, and excreted very slowly. Based on these properties, a simple and accurate method was developed to esti-

mate plasma volume with the use of the initial (10 minute) distribution space of ^{113m}In-transferrin. In 40 patients with a variety of disorders, ^{113m}In-transferrin spaces averaged 105% and ^{131}I-IgG spaces averaged 94.5% of simultaneously obtained ^{125}I-albumin spaces. In 20 normal subjects, the ^{113m}In-transferrin spaces averaged 35.7 ml/kilogram. Because of the short half-life of ^{113m}In, this method has several advantages over other available methods: use of ^{113m}In does not interfere with the subsequent use of other radionuclides; the radiation dosage to the patient is minimal; and the study can be repeated frequently without a need for correction for previously injected radioactivity, making possible serial estimation of plasma volume. A discrepancy between the specific activities of serum and oxalated plasma was observed incidentally. This was true for the iodinated proteins as well as for ^{113m}In. The specific activities of all three radionuclides in oxalated plasma samples averaged about 15% less than those of simultaneously obtained serum samples. Thus, plasma volume estimates obtained with the use of oxalated plasma to determine initial circulating specific activity were higher than those obtained with the use of serum. (auth)

29628 RADIOIMMUNOASSAY OF PEPTIDES LACKING TYROSINE. Newton, William T.; McGuigan, James E.; Jaffe, Bernard M. (Washington Univ., St. Louis. John Cochran Veterans Administration Hospital, St. Louis). J. Lab. Clin. Med.; 75: 886-92(May 1970).

Antibodies to the gastrin tetrapeptide moiety were utilized in the development of a new technique for radioimmunoassay. Since none of the four amino acids can be radioiodinated, and very high specific activity labels are required for immunoassay in the picogram range, tetrapeptide was conjugated to a random copolymer of glutamic acid, alanine, and tyrosine, and the conjugate was labeled with ^{125}I to specific activities as high as 2.5 mc per microgram of tetrapeptide. This conjugate served as the radioactive label in an immunoassay system which was sensitive to 60 pg, and in all characteristics, including specificity, total inhibitability by unlabeled inhibitor, and linearity of the relationship between antibody-bound radioactivity and the logarithm of added inhibitor, compared with radioimmunoassay systems with the use of labeled haptens directly. This method is applicable to the sensitive measurement of small peptides and other compounds which can otherwise not be iodinated. (auth)

29629 THE EVALUATION OF AN ERYTHROCYTE KINETIC TEST. Miller, J. P.; Kennedy, Mary Jo (Abbott Labs., Chicago). pp 3-14 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

The erythrocyte kinetic test was designed to measure the active and passive transport of ^{86}Rb by erythrocytes in vitro. In this test ^{86}Rb is used as a tracer of potassium in the study of cation metabolism of human erythrocytes. Heparinized whole blood is incubated at 37°C and ^{86}Rb is added to the sample in order to measure the pumping rate of the rubidium by the red blood cell. A rapid and accurate means has been developed to determine the rate of cellular uptake of the ^{86}Rb. By plotting the uptake curve, the rate of active uptake, AU, and outward diffusion, OD, can be computed. All values are corrected to a standard hematocrit value. Variations in the normal pumping rate of ^{86}Rb by erythrocytes, as reflected by changes in AU and OD values, have been observed in disease states and in patients treated with digitalis or its derivatives. The average erythrocyte AU and OD of a control group of 15 female patients was 0.448 and 0.226% per minute respectively compared with 0.445 and 0.217% for a group of 26 male patients. When compared with the controls, AU and OD were significantly greater in cancer subjects, $p = 0.001$. A group of 19 female patients, with clinically diagnosed carcinoma of various types, demonstrated an average AU of 0.555% per minute and an OD of 0.312% per minute and AU and OD in a similar group of 21 male patients with carcinoma was found to average 0.595 and 0.323% per minute respectively. These studies have been verified in other laboratories and results are summarized. (auth)

29630 STUDIES ON THE STRUCTURE AND METABOLISM OF THE NON-HAEMOGLOBIN IRON-BEARING COMPONENT OF THALASSAEMIC RED CELLS. Malamos, B.; Levis, G.; Gyftaki, E.; Kesse-Elias, Matina; Mantzos, J. (Athens Univ. Alexandra Hospital, Athens). pp 15-27 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

The incorporation of ^{59}Fe or both ^{59}Fe and L-Leucine-^{14}C simultaneously into the non-heme protein components of erythrocytes from thalassaemic patients and normal subjects was studied by gel cation exchange chromatography of the soluble hemolysate of cells incubated in vitro with the radioactive compounds. It was found that both ^{59}Fe and Leucine-^{14}C are incorporated into a non-heme protein, emerging at pH 6.4 from the column as a single peak with coinciding maxima of protein, nucleic acid, ^{59}Fe, and ^{14}C. Hemoglobin was eluted at pH 8. Fractionation with ammonium sulphate of the material of this peak, deriving from incubation with ^{59}Fe, showed that the fraction sedimented between 40% and 60% saturation had the highest specific radioactivity. The absorbances at 260 nm of all ammonium sulphate fractions were constant. Fractionation on a long CM-Sephadex column resulted in improved separation of the iron heme ^{59}Fe-bearing protein from nucleic acid-like compounds. To gain some insight on the physiological role of this compound, time studies were performed in which red cells incubated in vitro with ^{59}Fe for 30 min were freed from free ^{59}Fe and reincubated for four hr to study the fate of ^{59}Fe non-heme protein. It was found that, compared with those of normal, in red cells from thalassaemic patients there is an increased utilization of the ^{59}Fe-labelled non-heme protein, shown by an increase of specific radioactivity of hemoglobin. (auth)

29631 IN VITRO STEROID BIOSYNTHESIS WITH VARIOUS LABELLED SUBSTRATES IN DIFFERENT COMPONENTS OF THE HUMAN OVARY. Forleo, R.; Sbiroli, C. (Univ., Rome). pp 29-42 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

Details are presented of five years of intense systematic research to evaluate the various enzymatic activities implied in the synthesis of steroids in the different components of the normal and the pathological ovary. Research was carried out by incubating components (fragments of stroma, follicles, and corpora luta) of ovarian tissue removed during laparatomy with various ^{14}C- or ^{3}H-steroids. All the incubations were carried out under identical conditions, and the quantity of tissue incubated and the radioactive substrate added were kept at a constant ratio. In some cases the incubations of a tissue were stopped at different times to show the development of the various enzyme activities. Particular attention was paid to the problem of the ovarian stroma. Although the presence of some enzymatic activity was noted in this part of the ovary, the authors believed it to be far less than that found in the follicle or the corpora luta. Dynamic studies on the function of the corpora luta showed a lack of desmolase, together with dehydrogenase and aromatization. It was concluded that this method is, at present, the only one able to differentiate between the steroidogenetic potentiality of the various components of human ovarian tissue. (auth)

29632 EFFECT OF DIFFUSION ON THE AUTORADIOGRAPHIC MEASUREMENT OF MACROMOLECULAR SYNTHESIS IN SPECIFIC CELL TYPES IN VITRO. Dixon, K.; Schwarz, V. (Manchester Univ., Eng.). pp 47-57 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

Organ slices cultured in vitro lack a capillary circulation. Cells within the slice are supplied with nutrients and oxygen by diffusion from the culture medium into the slice. The rate of synthesis of macromolecules, e.g., ribonucleic acid, deoxyribonucleic acid, protein, or mucopolysaccharide can be determined in these circumstances by adding labeled precursors to the culture medium. Comparisons of the rate of synthesis between different types of cell within a single organ slice or between different slices can be quantitated by autoradiography and grain counting only if the concentration of labeled precursor in tissue water is uniform throughout all the slices. To achieve this aim the precursor should rapidly saturate the tissue water at the beginning of the incubation period, and subsequently diffusion into the slice should keep pace with consumption of the precursor by the cells. Experimental methods to measure the relevant parameters of any organ slice and precursor combination are described. These parameters are the diffusion coefficient of the precursor in the organ slice, the rate of consumption of the precursor by each cell type, and the frequency and distribution of tissue within the slice. The relation between precursor concentration and position within the slice can be calculated under differing culture conditions, using the appropriate mathematical model. It is then possible to choose those conditions which give a uniform concentration of precursor throughout the organ slice. The methods are illustrated by consideration of ribonucleic acid synthesis from ^{3}H-uridine in full thickness slices of human skin, an organ which contains several tissues including epidermis, hair follicle, sweat gland, and sebaceous gland. (auth)

29633 ESTIMATIONS OF THE DNA SYNTHESIS RATE OF BONE MARROW CELLS AFTER ADMINISTRATION OF LABELLED

THYMIDINE IN VITRO. Doermer, P.; Brinkmann, W. (Inst. of Haematology, Munich). pp 59-70 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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Bone marrow cells were incubated with tritium-labeled thymidine under varying in vitro conditions. The incorporation rate of labeled thymidine into DNA was influenced by the condition and duration of the in vitro incubation. Similar influences operate on the pool size of labeled thymidine phosphates. Up to concentrations of 10^{-6} M thymidine in the incubation medium there is a linear relation of thymidine concentration and thymidine incorporation into DNA. Concentrations of thymidine exceeding 10^{-6} M lead to increasing inhibition of the thymidine kinase. The endogenous formation of the thymidylate cannot be inhibited entirely by exogenous thymidine supply. Consequently, determinations of the DNA synthesis rate from the incorporated amount of labeled thymidine have to be corrected for the respective endogenous thymidylate contribution. A better procedure is to block the formation of endogenous thymidylate by means of amethopterin. Standard conditions are described, under which an undisturbed synthesis of DNA thymine from exogenous thymidine only takes place. Determinations can be performed by means of autoradiographic or biochemical techniques. By application of the semi-automatic grain counting technique, after sufficient autoradiographic standardization, evaluations of DNA synthesis rates and DNA synthesis times of different cell types in the bone marrow become practicable. (auth)

29634 USE OF BIOPSY TISSUE SAMPLES, INCUBATED IN VITRO, FOR AUTORADIOGRAPHIC MEASUREMENT OF CELL PROLIFERATION IN HUMAN TISSUES. Galand, P. (Univ. Libre, Brussels). pp 71-84 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970). (In French).

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To avoid the radiobiological hazards linked to the use of ^{3}H-thymidine, several workers have performed in vitro incubations of biopsy material in the presence of this labeled DNA-precursor. Attempts were made to define the proliferative pattern of the tissue from the distribution and intensity of labeling in autoradiographs. However, for true estimation of the cell cycle length, one has to know the S-phase (DNA-synthesis phase) duration, since the labeling index reflects only the part taken by this phase in the whole cell cycle. The double-labeling technique with two dose levels of ^{3}H-thymidine was used. By administering two pulses of the tritiated precursor (a weak dose and a heavy dose) at a given time interval and submitting the treated tissue to the autoradiographic process, one can calculate the S-phase duration(s) after the formula $N_h/N_W = S/t$, when N_h is the number of heavily labeled nuclei (i.e., those nuclei that were engaged in S-phase during the second pulse labeling) and N_W is the number of weakly labeled nuclei, corresponding to the cells which left S-phase during the time interval (t) between the two pulse labelings. From the percentage of heavily labeled nuclei in the whole population (L.I.), the generation time (G.T.), is then given by the formula G.T. = S/L.I. × 100. Human rectal and gastric biopsies were submitted to this procedure which, because of its brevity, requires simple survival conditions. Normal and pathologic cases were studied. Endometrial tissue is also currently under study. In parallel, experiments on animal tissues were also performed in order to make a comparison for the same individual between in vitro and in vivo measurements. This latter was realized by the classic method of the wave of labeled mitoses. The following aspects were examined; proper choice of the dose range, for valid recognition of weakly and heavily labeled cells; choice of the region of the sample where homogeneous labeling occurs after the diffusion of the labeled thymidine; and tests on the stability of the biopsy during incubation. This was done by using varied time interval between ^{3}H-thymidine administrations. The good correlation between the results obtained in this way also gives supports to the validity of our distinction between the two kinds of labeling intensity. This method could be applied to several types of tissues, provided they can be obtained by biopsy, and with proper safeguards, namely in the choice of the doses range and in the definition of the proliferating population. (auth)

29635 GENERAL ASPECTS OF DERIVATIVE ANALYSIS. Keston, A. S. (Inst. for Medical Research and Studies, New York. City Univ., New York). pp 87-96 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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The general aspects of the isotope derivative method of analysis and its applications to the determination of organic compounds are discussed. In this method a mixture is treated with an isotopic reagent to form isotopic derivatives of the substances being analyzed. Several variations of the method involving carriers and indicators are examined. The method has extremely high sensitivity, being operable below the nanogram level, and possesses the inherent specificity and accuracy characteristics of isotope techniques. (auth)

29636 APPLICATION OF DOUBLE ISOTOPE DERIVATIVE DILUTION PROCEDURES FOR STEROID HORMONE MEASUREMENT. Scoggins, B. A. (Univ. of Melbourne); Coghlan, J. P.; Oddie, C. J.; Wintour, E. M.; Cain, M. D.; Hudson, B. pp 97-112 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

The measurement of the concentration of specific steroid hormones in human peripheral plasma has required the development of sensitive analytical procedures. Of the various analytical techniques available, procedures based on the principle of double isotope derivative dilution have great specificity and precision at low levels, and can be readily applied to the measurement of androgens, estrogens, progesterone, and adrenocortical hormones. In these procedures a known amount of ^{14}C- or ^{3}H-labeled steroid is added to the sample as an internal recovery indicator to account for losses over the various analytical steps. Mass is determined by formation of a labeled derivative of the hormone following reaction with a radioactive reagent of known specific activity. These reagents are usually either ^{3}H- or ^{35}S-labeled. Separation of the various steroid hormones from each other and from the excess radioactivity arising from derivative formation is carried out by chromatography and by further chemical modification of the labeled derivative. The problems of developing a method suitable for the measurement of aldosterone in human peripheral plasma are described, and a comparison made between two methods, one which uses ^{14}C-aldosterone as internal indicator and ^{3}H-acetic anhydride for derivative formation, and another which uses ^{3}H-aldosterone and ^{35}S-tosan (toluene sulphonic acid anhydride). The subsequent modification of the basic ^{3}H-acetic anhydride procedure to enable simultaneous measurement of cortisol, cortisone, corticosterone, desoxycortisol, desoxycorticosterone, dehydroepiandrosterone, and testosterone in a single sample are described. The application of these procedures to the measurement of progesterone and estrone and estradiol-17β are also discussed; in particular, the enzymatic reduction of progesterone to enable acetylation, or the use of ^{35}S-pipsyl chloride (p-iodo benzene sulphonyl chloride) for derivative formation. The advantages and disadvantages of this type of methodology are also discussed with particular reference to specificity, accuracy, precision, and suitability for routine analytical use. The sensitivity and precision of double isotope methodology is dependent not only on the specific activity of the labeled reagents but also on the performance of the liquid scintillation counting system. Statistical counting errors and an assessment of the precision and reliability of liquid scintillation counting systems used to count samples containing ^{3}H and ^{14}C are described. (auth)

29637 A METHOD FOR THE DETERMINATION OF ALDOSTERONE IN SMALL FRACTIONS OF URINE. Engelhardt, D.; Koczorek, K. R. (Univ., Munich). pp 113-20 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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Several procedures for the determination of urinary aldosterone are known, but they are either too time consuming, uncertain in their specificity or too insensitive. Therefore a relatively simple method of determining aldosterone in small fractions of urine is described. Utilizing a sensitive colorimetric analysis for the final estimation and the addition of 4-^{14}C-D-aldosterone as internal standard, the recently modified method of Neher and Wettstein was further simplified and increased in its sensitivity. A $^{1}/_{10}$th fraction of a 24-hr urine is required for each determination. The procedure is essentially as follows: (1) Acid hydrolysis of a one-tenth fraction of the 24-hr urine at pH 15 for 24 hr at 23°C; (2) Addition of 4-^{14}C-D-aldosterone as the internal standard; (3) Repeated extraction with dichloromethane; (4) Successive paper chromatographic fractionation employing two systems of the Zaffaroni-type (F/EBW; F/$CHCl_3$) localizing 4-^{14}C-D-aldosterone and the urinary aldosterone with a radiochromatogram scanner; (5) Final estimation (in microlitre cuvettes) by a micro-blue-tetrazolium reaction applied to the steroid eluted from the chromatograms including correction of the losses during the procedure. The accuracy, precision, sensitivity, and specificity

of the method are discussed. The normal and pathological urinary aldosterone values obtained by this method are in agreement with those reported in the literature. (auth)

29638 QUANTITATIVE DETERMINATION OF OXALATE IN URINE BY DOUBLE ISOTOPE LABELLING TECHNIQUE. Foss, O. P. (Ullevaal Hospital, Oslo). pp 121-33 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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The sample of urine is labeled with a known amount of ^{14}C-oxalate. The oxalate is extracted from the sample and precipitated with calcium labeled with ^{45}Ca. The specific activity of the calcium must be known. The molar specific activity of the ^{14}C-oxalate is the same in the sample as in the precipitated calcium oxalate. Further the molar specific activity of the ^{45}Ca is the same in the calcium used for the precipitation as in the calcium oxalate formed. Oxalate must be precipitated only as calcium salt and calcium precipitated as oxalate only. Then the unknown amount of oxalate in the sample may be expressed as micromol equals. (auth)

29639 IN VITRO DETERMINATION OF PLASMA TRANSPORT COPPER (DIRECT REACTING COPPER) BY EXTRACTION AND ATOMIC ABSORPTION USING AN ISOTOPE DILUTION PROCEDURE. Binnerts, W. T.; Boom, W. G. (Landbouwhogeschool, Wageningen, Netherlands). pp 135-42 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

Plasma transport copper is a better means of evaluating the copper status of an individual than total plasma copper because it reveals instantaneous changes in copper supply in contrast to ceruloplasmin, liver copper, or hair copper contents. The method most applied for determining transport copper is the direct reacting copper method described by Gubler et al. (1953). The drawback of this method is low extinction values and interferences of several kinds. When the plasma is colored, e.g., by ingestion of carotene, the interferences are particularly great. A method of extraction followed by atomic absorption analysis is described. To the plasma samples ^{64}Cu is added so that the recovery in the extraction procedure can be corrected by simple isotope dilution. This in vitro method is rapid, allows appreciably more accuracy, and does not suffer from interferences. Some results of determinations are given; the method should be applicable to all types of plasma. (auth)

29640 ENZYMIC REDUCTION OF ^{3}H-FOLIC ACID: A MODEL APPLICATION FOR RADIOENZYMATIC ASSAY PROCEDURES. Rothenberg, S. P. (New York Medical Coll., N. Y.). pp 145-66 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

A radioenzymatic method has been developed to monitor the reduction of tritiated folic acid to tetrahydrofolic acid using the enzyme folate reductase and the cofactor NADPH. By appropriately altering the conditions of the reaction system the methodology has been adapted as a radioassay for low concentrations of unlabeled folic acid; the folic acid antagonists; the enzyme, folate reductase; the cofactors NADPH and NADP; and any NADP-NADPH oxidereductase enzymic reaction. The principles described should have application to other enzymic systems. (auth)

29641 DETERMINATION OF DIGITALIS IN BLOOD. Gjerdrum, K. (Ullevaal Hospital, Oslo). pp 167-74 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

The desire for better control of digitalis therapy and the increasing frequency of digitalis intoxications have made the need for digitalis determination in blood imperative. Cardioactive digitalis glycosides decrease the active transmembrane transport of Na and K by inhibition of Na-K-activated ATPase. The phenomenon was cleverly employed by Lowenstein for digitalis determination. His method has been studied and the optimal conditions of each step have been investigated. Digitalis in plasma standards and patients' samples is extracted with dichlormethane. Transmembrane transport is followed with ^{86}Rb, an isotope that is treated as potassium by the erythrocytes. Normal erythrocytes are incubated with 1 μCl ^{86}Rb and the plasma extracts. After four hr incubation nearly 80% of the ^{86}Rb has been transported into the cells in the tubes without digitalis. With increasing concentrations of digitalis the intracellular transport is inhibited, and increasing quantities of ^{86}Rb remain in the extracellular fluid. The counts per minute in 0.2 ml clear supernatant from the standard solutions form the basis of the standard curve from which the digitalis concentrations in the patients' samples can be read. The modified method can determine all used digitalis glycosides. The analytical coefficient of variation is about 10% with digitoxin in the therapeutic plasma range (10-30 ng/ml). With purified enzyme preparations numerous medicaments have been described as Na-K-activated ATPase inhibitors. The present method with intact erythrocytes shows no significant interference by other preparations than digitalis. The determination of one long series of samples will require two days, and the time spent on each patient's sample in duplicate will be about 10 min. (auth)

29642 ENZYMATIC DETERMINATION OF CHOLINE IN BRAIN WITH CHOLINE PHOSPHOKINASE AND ^{32}P-LABELLED ATP. Ewetz, L.; Sparf, B.; Soerbo, B. (Research Inst. of National Defence, Syndyberg, Sweden). pp 175-83 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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An enzymatic assay for free choline in brain has been developed. Rats or mice were killed by freezing in liquid nitrogen and the frozen brain was extracted with trichloroacetic acid. Interfering compounds were removed on an anion-exchange resin and choline was converted to ^{32}P-phosphorylcholine by the action of choline phosphokinase and ^{32}P-ATP. The labeled phosphorylcholine obtained was separated by chromatography on Amberlite CG-400 (chloride form), and its radioactivity determined. The choline levels in rat and mouse brain were found to be 39 nmole/g and 42 nmole/g respectively. These values are considerably lower than those previously reported in the literature, apparently because of the increased specificity of the present method. (auth)

29643 IN VITRO IMMUNOLOGIC STUDIES WITH AN ^{131}I-LABELLED COMPONENT OF COMPLEMENT. Spar, I. L.; Benz, L. L. (Univ. of Rochester, N. Y.). pp 187-98 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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Most of the in vitro immunological studies using radioactive isotopes have involved labeling of the reacting antigen or antibody. For meaningful results, it is also necessary to use a relatively purified preparation of either the antigen or antibody. This has been difficult to obtain when the antigenic component is illdefined, as in tissue or tumor immunity. It seemed possible that detection of reactions of this type could be done more easily by using labeled components of hemolytic complement, since some of the factors involved in this 9-11 factor system are known to firmly bind to most antigen-antibody combinations. As an initial step in this study, ^{125}I- or ^{131}I-labeled components of complement were used to detect and quantitate known antigen-antibody systems. The initial reacting component of guinea pig complement, C'1, was partially purified and labeled with ^{125}I or ^{131}I. It was found that labeled C'1 would react with ovalbumin-antiovalbumin (OA) precipitates and would bind to sensitized sheep cells (EA) in proportion to the amount of hemolysin bound to the cells. EDTA elusion of such bound ^{125}I-C'1 yielded a product that would react with EA or OA to a much greater extent than the starting material. In addition, lysis of EA would occur after binding of eluted ^{125}I-C'1 if the remaining complement components were added to the system. In further studies it was found that ^{131}I-C'1 could be used to detect reactions between anti-kidney antisera and homogenates of kidney, liver, and lung. Extension of this work with isotopically labeled components of complement to a study involving tissue sections after incubation with antisera could lead to detection of tissue-antitissue antibody binding in situ. By utilizing autoradiographic techniques, one can further extend this system to define the site of antibody fixation. A distinct advantage of this approach is that the isotopically labeled reactant, complement, is reasonably pure and thus can be used with crude antigens or unpurified antisera with many different immunological systems. (auth)

29644 AN IN VITRO HISTOCOMPATIBILITY TEST IN A SEARCH FOR TUMOUR ANTIGEN. Vodopick, Helen; Rupp, Elizabeth M.; Gengozian, N. (Oak Ridge Associated Universities, Tenn.). pp 199-208 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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The in vitro mixed leukocyte culture test has been used to study the histocompatibility between related and unrelated persons. One application has been to select donor-recipient candidates for bone marrow and tissue transplants. An attempt was made to detect

tumor antigen with this test. Blastic transformation of lymphocytes, taken as an index of incompatibility between two different populations, is evaluated by incorporation of tritium-labeled thymidine into cells stimulated to synthesize DNA. One population of the mixture is exposed to a DNA inhibitor, mitomycin C, which renders these cells incapable of incorporating the radioactively labeled thymidine but allows the cells to stimulate the uninhibited populations. The undirectional reaction permits maximal stimulation of the uninhibited population. This system has been used to study the reactions between malignant cells and both autologous and homologous lymphocytes. Inhibited malignant cells cause minimal stimulation of circulating lymphocytes from the same patient. However, when inhibited tumor cells and inhibited circulating lymphocytes from the same patient are tested separately against normal homologous lymphocytes, the tumor cells produce the greater stimulation. This reaction suggests that tumor tissue contains some antigenic substance absent from the patient's lymphocytes; this substance may represent tumor-specific antigens. Such differences cannot be attributed to isoantigens since both stimulating cells come from the same patient. The recognition and isolation of such an antigen is fundamental to the understanding of tumor growth. (auth)

29645 RADIOACTIVE SINGLE RADIAL DIFFUSION. A SENSITIVE METHOD FOR THE ESTIMATION OF ANTIGENS IN AGAR GEL. Rowe, D. S. (Univ. of Lausanne, Switzerland). pp 209-11 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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Gel diffusion techniques using specific antiserum are commonly used for the detection and estimation of proteins in serum and other body fluids. One commonly used method is the single radial diffusion technique of Mancini et al. (1965). This method has a practical limit of sensitivity of approximately 10 μg/ml. This level of sensitivity renders it unsuitable for the measurement of trace components of plasma including, for example, IgE. Radioactive single radial diffusion (Rowe 1969) is a modification of single radial diffusion. It relies on the fact that precipitates may be present in agar gel which are invisible either directly or by staining. After production of the precipitate and washing of the plate the agar is exposed to a ^{131}I-labeled antiserum reactive with the animal immunoglobulin in the precipitate. The plate is again washed and the radioactivity specifically bound to the precipitate area is visualized by exposure of the agar plate to photographic film. In this way the sensitivity of the single radial diffusion method can be increased at least 60-fold and approximately $\frac{1}{20}$th of the volume of specific antiserum is required. The method has particular application to the measurement of serum IgE and is generally useful for the measurement of concentrations of proteins in plasma and other body fluids down to 100 ng/ml. Radioactive single radial diffusion is described in detail and some of its possible applications discussed. (auth)

29646 USE OF ANTIGENS LABELLED WITH RADIOACTIVE ISOTOPES IN SEROLOGICAL EPIDEMIOLOGY. Felsenfeld, O.; Parrott, M. W. (Tulane Univ., Covington, La.). pp 213-17 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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Radioactive labeled antigens, feasible for use with small amounts of sera, were used for rapid examination of large numbers of blood samples. The antigen-antibody complexes are formed in filter paper (cellulose) pads and the counting performed in the gas flow or the liquid scintillation counter. The results were compared with those of passive hemagglutination. Radioactive labeled (^{14}C or ^{3}H) antigens were more sensitive. Further investigation of such antigens is recommended. (auth)

29647 NEW DEVELOPMENTS IN RADIOISOTOPIC IN VITRO THYROID FUNCTION TESTS. Goolden, A. W. G. (Hammersmith Hospital, London. Royal Postgraduate Medical School, London). pp 221-8 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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Current views on thyroid hormone transport are summarized. Recent work suggests that thyroxine-binding prealbumin (TBPA) plays only a minor part in thyroxine transport. It is doubtful whether changes in the concentration of this protein are of importance in determining the concentration of free thyroxine. Various methods for measuring T3 uptake using ^{125}I or ^{131}I as tracers are compared. These tests provide information about the number of unoccupied binding sites on thyroxine-binding globulin (TBG) and this information is best utilized in conjunction with a PBI or serum thyroxine determination. The measurement of serum thyroxine by competitive protein binding analysis has certain advantages over the PBI, and is a useful addition to existing thyroid function tests. Various methods for the measurement of free thyroxine are outlined. The use of a free thyroxine factor is a simpler alternative to the direct measurement of free thyroxine. (auth)

29648 AUTOMATED HAMOLSKY TEST: ITS VALUE IN THYROID FUNCTION EXAMINATION. Roucayrol, J. C.; Remy, J. M.; Ingrand, J. (Hopital Cochin, Paris). pp 229-42 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970). (In French).

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The interest aroused by the Hamolsky test is caused essentially by the fact that this test, which is performed in vitro, does not involve irradiation of the patient and that it is in general the only test capable, in the presence of iodine saturation of exogenic origin, of providing information on the functional state of the thyroid. The adsorbents used in classical manual techniques were replaced by a dialysis membrane which effects continuous separation of the free radioactive T3 (1-tri-iodothyronine-^{131}I) from the protein-bound hormone after incubation with the plasma for analysis. The automatic recording of a non-stop dialysis and the continuous comparison of the plasmas with a reference plasma enable variations to be detected in the analytical device, thus ensuring very great accuracy in the results. Critical examination of this method, which has been performed since 1966 on almost 400 patients, shows that the automated version of the Hamolsky test can be adopted as a routine technique in the functional investigation of the thyroid. The advantages and disadvantages of this test and of the manual tests using resins are discussed in detail. (auth)

29649 AN ASSESSMENT OF THE TRI-IODOTHYRONINE UPTAKE TEST USING A DIAGNOSTIC KIT. Goodhead, L.; McAlister, Joan M. (St. Bartholomew's Hospital, London). pp 243-53 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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After failure to obtain reproducible results with the tri-iodothyronine uptake test using, in turn, red cells, resin powder, and resin paper, the Abbott's Triosorb kits were tried and found satisfactory. They were put into clinical use, however, problems were encountered with changes in the standard serum values and other inconsistencies. A program was initiated to investigate thoroughly the reliability of the method. Comparisons were carried out with other hospitals, checks on different standard sera and plasma were made, and clinical measurements were done on duplicate samples. The findings of these investigations are reported. A change was made from the ^{131}I- to the ^{125}I-labeled tri-iodothyronine and these results are also reported. (auth)

29650 STUDIES ON THE COLD INCUBATION METHOD IN THE ^{131}I-T3 RESIN SPONGE UPTAKE TEST. Tsuchiya, T. (National Inst. of Radiological Sciences, Chiba, Japan); Takino, H.; Kurata, K.; Wakebayashi, T.; Ito, K.; Nishikawa, T.; Ino, E.; Momotani, N. pp 255-61 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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An attempt was made to establish a new method that eliminates the correction factors in incubation time and temperature of T3 resin sponge ^{131}I uptake test. Each pooled serum in three different states of thyroid function, i.e., hyperthyroid, euthyroid, and hypothyroid, was separately incubated for 20, 24, and 28 h with T3 resin sponge either in a cold room at 2°C, 5°C or 8°C, or in a refrigerator adjusted to 5°C. The T3 uptake values in each pooled serum were not affected by the difference in the temperature and the incubation time in the cold incubation method. Applicability of the present method (using refrigerator) was examined in about 200 cases of different states of thyroid function. The values obtained by the strictly controlled conventional method (25°C, 1 h) showed a good correlation with those obtained by the new method. In cases of hypothyroidal state the present method yielded a wider range of uptake values than the conventional one, and hence provided a better method of distinguishing thyroidal function. (auth)

29651 INTERPRETATION OF THE T_3 UPTAKE TEST. Meuret, G.; Hoffmann, G. (Univ., Freiburg i. B.). pp 263-71 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970). (In Spanish).

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The binding of triiodothyronine (T_3) by the plasma proteins and adsorbers used in the ^{131}I-T_3 resin sponge uptake test was analyzed. The influence of various factors on the uptake of T_3 by the test adsorber was examined. Concentration of triiodothyronine, thyroxine (T_4), proteins, and lipids in the plasma and the thyroxine binding capacity of plasma proteins having a high affinity for T_4 is described. Interpretation of the test for purposes of clinical applications is discussed. (auth)

29652 LABELLED T_3, T_4, AND TBP FOR IN VITRO TESTING OF THYROID FUNCTION IN MAN AND ANIMALS. Czerniak, P. (Tel-Aviv Univ., Israel); Boruchowski, Sabina; Shomron, I. pp 273-86 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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Iodothyronines are bound to electrophoretic fractions of serum proteins, TBP (TBG, TBA, TBPA). Radioiodine labeled T_3 and T_4 complex the free TBP fractions until saturation. The excess of added in vitro thyronines is then absorbed by the RBC. The changes described can be detected and quantitatively determined by radioisotope tests: radioelectrophoresis (T_4 BP test), and RBC-^{125}I T_3 (Hamolsky test). The in vitro tests of the thyroid function can be clinically reliable if the protein fractions are normal, and they may be altered without thyroid pathology if the TBG fractions are abnormal. The electrophoretic fractions vary quantitatively and qualitatively in animals of different classes and orders. We chose these features to study the correlation between iodothyronines, plasma proteins, and the above-mentioned thyroid tests. Twenty-two animal species (arranged according to the increasing percentage of the Hamolsky test) were examined: goat (8.6%); cow; lamb; calf; man; camel; goose; hamster; rat; turkey; marmot; duck; horse; donkey; hen; dog; pigeon; rabbit; guinea pig; mouse; fish; and frog (91.5%). The following additional parameters were examined: PBI; serum quantitative electrophoresis; and T_3 BP studies. All the tests were performed under identical technical conditions. The Hamolsky test in the examined animals ranged from 9% to 92%. It is highest in the poicolothermics, in which much prealbumin and few globulins are found on electrophoresis. The T_3 BP was low, and about a half of the added ^{125}I T_3 remained unbound. T_3 and T_4 were complexed with T_3 BP and T_4 BP fractions, which correspond to prealbumin, albumin, alpha 1-2, beta and exceptionally gamma globulin. The fractions were variable but characteristic for each animal species. T_3 BP did not correlate exactly with T_4 BP, and seemed to be distributed over more fractions. Diminution of T_3 BP in the serum of a given animal resulted in an elevated Hamolsky test (frog, fish, pigeon, guinea pig). There was no correlation between the RBC-I-T_3 test and the PBI of the animals examined. The ascending curve of the Hamolsky tests crossed the descending curve of PBI (passing from goat to frog) in the rat-position. The in vitro tests examined remain specific but unchanged for each animal species, if the serum and the technique used remain unchanged. If the electrophoretic fractions change, the results of the in vitro tests change too, becoming similar to another species. The human serum composition is generally stable and the in vitro tests are reliable in 70 to 80% of these cases. In cases of discrepancy and for a complete study of the RBC-I T_3 test it is advisable to add serum electrophoresis and T_3 BP determination. (auth)

29653 MEASUREMENTS OF ^{131}I-LABELLED TRIIODOTHYRONINE UPTAKE BY A RESIN AS A MEANS OF DIAGNOSING IODINE-BASEDOW PRODUCED BY INTRAMUSCULAR ADMINISTRATION OF IODIZED OIL IN AN AREA OF ENDEMIC GOITRE. Fierro-Benitez, R.; Ramirez, I. (Univ. Central, Quito). pp 287-97 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970). (In Spanish).

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Studies of thyroid function in an area of endemic goiter in Ecuador involving the whole population of two rural communities were begun in March 1966. The final control check came three years later. Ethiodol (37% iodized oil, 450 mg iodine per cm^3) was injected intramuscularly, 2 cm^3 being administered to subjects 12 years of age and older and proportionately smaller doses to younger children. The ethiodol produced extensive changes in the physiological behavior of the thyroid. The ^{131}I uptake was depressed for six months and afterwards remained normal. Similarly, BEI and T_4 returned to and stayed at normal levels from the very first control checks onwards, which indicated that even during the first few months the thyroid glands of these subjects were maintaining a normal capacity to secrete thyronines, and PBI and BII maintained high levels in all the controls. Urinary excretion of iodine followed a double exponential path: calculations indicated that the subjects would still be excreting significant amounts five years after the injection. Among the indices which proved useful for evaluation of thyroid function and the diagnosis of goiter were BEI, T_4, BMR, and the various tests with radioiodine (uptake, conversion ratio, PBI %/1/d, urinary excretion, saliva/total plasma, saliva/PBI, salivary clearance, KSCN suppression test). The measurements of T_3-^{131}I uptake by resin proved most valuable for diagnostic use. (auth)

29654 DIAGNOSTIC VALUE OF SERUM TOTAL THYROXINE, RESIN UPTAKE, AND FREE THYROXINE INDEX. Murray, P.; Joasoo, A.; Parkin, J. (Prince of Wales Hospital, Sydney). pp 299-308 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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The diagnostic accuracy of two methods for the estimation of serum total thyroxine was studied in two series of normal subjects and patients with thyroid disease. Direct comparison was also obtained by measurement of the thyroxine level by both techniques in 91 individuals. The commercial kit, ^{125}I Tetra-sorb, proved to be as accurate as the Nakajima method and with advantages in simplicity. Moreover, the similarity of the technique to the ^{131}I Triosorb method for triiodothyroxine resin uptake is particularly useful when a large routine load demands both tests frequently. Thyroxine estimation was found to be more accurate than the triiodothyroxine resin uptake in correctly discriminating between euthyroid, hypothyroid, and thryotoxic patients provided that there was no abnormality in thyroxine-binding proteins. When such abnormalities are likely to be present, as for example in individuals on oral contraceptive therapy, or when the results of the primary tests are at marked variance with the clinical diagnosis, an expression relating the two tests is required. A Free-Thyroxine Index, obtained from the product of the thyroxine value and resin uptake is more diagnostically accurate than either test alone, but a Free-Thyroxine Factor, derived from a formula incorporating both values, is superior to the Index. Fallacies in the accuracy must, however, be recognized. In particular, it has been found that the total thyroxine and resin uptake may vary unpredictably in patients with chronic renal failure. In the majority of these patients, the thyroxine level is below normal. Frequently the associated change in resin uptake results in a normal Index or Factor but in a significant proportion of these euthyroid patients both these parameters are abnormal. These alterations have not yet been explained by studies of thyroxine-binding proteins nor associated biochemical abnormalities. (auth)

29655 A COMPARISON OF IN VITRO METHODS AND OTHERS IN THE ASSESSMENT OF THYROID STATUS. Gimlette, T. M. D.; Clarke, J. M. (Liverpool Clinic). pp 309-22 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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An assessment of thyroid status was carried out on 900 unselected patients referred to the clinic for this purpose. The methods used were the estimation of thyroxine, and the estimation of triiodothyronine binding coefficient, and these were combined to give a Free-Thyroxine Index. These results were compared with assessment by measurement of the 4-hr uptake of ^{132}I, supplemented by triiodothyronine suppression tests, and T.S.H. stimulation tests where indicated, according to standard procedures. They were also compared with the clinical indices for hyperthyroidism and hypothyroidism, and with measurement of the Achilles reflex time by standard technique. Normal values for the various techniques concerned were established for this clinic by measurement in a large number of patients, and were as follows: serum thyroxine, 8.1 μg/100 ml (±4.4); triiodothyronine binding coefficient, 103% (±34); free-thyroxine index, 8.3 (±4.6); 4-hr uptake of ^{132}I, 9 to 42%; Achilles reflex time, 312 ms (±110). A final assessment of thyroid status in the patients studied was made after consideration of all the available data from the tests, and in some cases after observation and subsequent retesting after a period of time. In 1.5% of patients a firm conclusion was not reached and some of these at least were probably true borderline cases. When the techniques were compared it was found that the estimation of the free-thyroxine index and the 4-hr uptake of ^{132}I supplemented by triiodothyronine suppression and T.S.H. stimulation tests gave results in agreement with the final diagnosis in about 97% of cases. The estimation of thyroxine, of triiodothyronine binding coefficient and of 4-hr ^{132}I uptake alone, and also that of the clinical indices and Achilles reflex time, gave results which were to a varying degree less reliable. These findings are discussed in relation to the selection of reasonably simple and reliable routine methods for the assessment of thyroid status. (auth)

29656 THEORETICAL ASPECTS OF SATURATION ANALYSIS. Ekins, R. P. (Middlesex Hospital Medical School, London). pp 325-53 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

Saturation analysis is a term originally introduced to describe assays relying on progressive saturation of a specific reactant by the compound one wishes to measure. The theoretical principles governing their sensitivity and precision are discussed, and the application of these principles, particularly to those systems relying on naturally occurring specific binding proteins, is discussed. Methods using radioisotopes as tracers for the measurement of hormones, vitamins, trace elements, antibodies, and selected biochemicals in body fluids are discussed. Applications in endocrinology are stressed. (C.H.)

29657 SIMPLIFIED ASSAY FOR VITAMIN B_{12} IN PLASTIC TUBES COATED WITH INTRINSIC FACTOR. Rubini, J. R. (Mount Sinai Hospital, Miami Beach, Fla. Univ. of Miami, Fla.). pp 355-8 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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Polymeric surfaces of some plastic test tubes can be firmly coated with protein solutions. A binding assay for vitamin B_{12} using plastic tubes coated with intrinsic factor (I.F.) was developed. The method is simple and economical. Intrinsic factor-coated tubes are prepared by placing an I.F. solution in plastic test tubes overnight. After pouring out and rinsing twice with normal saline, the coated tubes are drained, dried and stored at 4°C until ready for use. The assay for serum B_{12} is run with a set of known B_{12} standard solutions in albumin. The B_{12} is liberated from protein binders by acidification and boiling. The freed B_{12} is then mixed with 1000 pg high specific activity ^{57}Co B_{12} at pH 7.4 and poured into the I.F.-coated tubes. After standing for 24 hr to allow for equilibration and competitive binding of hot and cold B_{12}, the plastic tubes are emptied and rinsed twice with tap water. The wall-bound radioactivity is counted in a gamma counter. Tube counts/min are plotted for each B_{12} standard. An almost straight line curve is obtained. Tube counts/min of test sera are located on the standard curve and their B_{12} content read off. Serum B_{12} levels in 28 blood donors ranged from 400 to 2280 pg/ml with a mean of 1341 pg and a standard deviation of 503. Predicted B_{12} values for dilutions of normal sera agreed closely with levels experimentally determined. This test has proved stable and useful in clinical hematology. (auth)

29658 A SIMPLE AND RAPID AMBERLITE SATURATION ANALYSIS OF SERUM VITAMIN B_{12}. Roos, P. (Vrije Univ., Amsterdam). pp 359-79 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

Although the principle of the saturation analysis of various serum hormones is rather well known, most methods are still rather laborious and time-consuming. Efforts were made to find optimum conditions for the assay of serum vitamin B_{12} using Amberlite IR 120, CG type II in tablet form. A desk-top computer facilitates the calculation of hormone levels using a line equation with regression coefficient for the standards. In this way the time gained is considerable and a set of 20 samples takes eight hours' time. Accuracy, reproducibility, and normal serum levels are reported. (auth)

29659 CHARACTERIZATION AND DIFFERENTIATION OF ^{57}Co VITAMIN B_{12} IN VITRO BINDERS IN HUMAN SERUM. Meyer, L. M.; Gizis, E. J.; Dietrich, M.; Choi, G. (Queens Hospital Centre, Jamaica, N. Y.). pp 381-92 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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Characterization and differentiation of in vitro ^{57}Co B_{12} serum binders of normal subjects and pernicious anemia patients in relapse were studied by three techniques. In the first step 300 pg of high specific activity ^{57}Co B_{12} were added per ml to 30 ml of normal serum. The reaction mixture was chromatographed on a 3 × 60 cm DEAE-cellulose column by elution with the following sodium phosphate buffers; 0.0175 M, pH 6.3; 0.04 M, pH 5.9; 0.1 M, pH 5.8; and 0.4 M, pH 5.2. A radioactive peak was eluted with 0.04 M buffer (TCII) and a second one with 0.4 M buffer (TCI). A third peak, eluted with 0.1 M buffer, was occasionally noted in some sera, frequently associated with larger amounts of ^{57}Co B_{12}. Discontinuous electrophoresis in 7% polyacrylamide gel using tris-HCl (pH 8.9) as running buffer and tris-glycine (pH 8.3) as electrode buffer, indicated that the radioactive peak eluted from normal serum with 0.04 M buffer (TCII) from DEAE-cellulose was associated with one band. Gel filtration of the same sample on Sephadex G-200 gave one peak of radioactivity. The binders eluted with 0.4 M buffer (TCI) and 0.1 M buffer differed from TCII in electrophoretic mobility and elution volume in that single bands and peaks were observed. These were all different from those seen with TCII. Serum of pernicious anaemia patients in relapse subjected to the same treatment showed a radioactive peak eluted from DEAE-cellulose column with 0.04 M buffer, differing from the corresponding normal serum peak in that it was separated into more than one ^{57}Co B_{12} binders by polyacrylamide gel electrophoresis and gel filtration on Sephadex G-200 column. One of the binders appeared similar to normal TCII while the others were eluted from the Sephadex column before TCII. The latter also differed from TCII and TCI in electrophoretic mobility. TCI from normal and pernicious anaemia patients appeared identical as did the radioactive peak eluted with 0.1 M buffer. Therefore, ^{57}Co B_{12} binders in normal and pernicious anemia patients' serum can be differentiated by ion exchange chromatography on DEAE-cellulose, followed by polyacrylamide gel electrophoresis or gel filtration. (auth)

29660 ASSESSMENT OF CORTISOL BINDING CAPACITY BY PLASMA FROM NIGERIANS. Adadevoh, B. K.; Oyefeso, J. A. (Univ. of Ibadan, Nigeria). pp 393-402 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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Whereas the urinary excretion of adrenocortical steroids in the African has been shown to be consistently lower than in non-Africans, adrenocortical function studied by plasma cortisol measurements has revealed no differences. The variation in plasma protein in Africans, especially the reversal in albumin-globulin ratio, may influence the binding of cortisol and thereby its metabolism. This factor may account for the discrepancy in the observations on plasma and urinary steroids. Using a simple method adaptable to routine usage in which Sephadex G-25 and ^{14}C-labeled cortisol are employed, the binding capacity of plasma from Nigerians in vitro is determined. The results are assessed in terms of normal samples and conditions in which changes in protein pattern occur. (auth)

29661 DETERMINATION OF TESTOSTERONE IN URINE BY DISPLACEMENT ANALYSIS. Stoea, K. F.; Bessesen, A.; Bjoernsen, B. A. (Univ. of Bergen). pp 417-26 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

A method was developed for determining testosterone in urine using competitive protein binding. Plasma from pregnant women is used as a source of testosterone binding globulin. The steroid to be quantitated is incubated with a solution containing the assay protein and a tracer dose of ^{3}H-testosterone with high specific activity. Separation of bound and free testosterone is effected by subsequent adsorption to dextran-coated charcoal particles. One-ml urine volumes are used for each analysis in men and 5 ml in the case of women and children. Following enzyme hydrolysis and ether extraction, testosterone is isolated and purified by paper chromatography in the system n-hexane : benzene (2 : 1) : formamide, and on silica gel thin layer with benzene : ethyl acetate (1 : 1). To correct for methodological losses, an internal standard of 1, 2-^{3}H-testosterone is added to the urine sample before processing. The accuracy and the precision of the method are satisfactory. The application of two different chromatographic systems appeared to be necessary to obtain adequate specificity. The method has been used in analyses of urine from a number of normal individuals. The mean testosterone excretion in 18 men was found to be 84.1 μg/24 h (variation range: 22.7-155.0). In 19 normal women the mean was 11.1 μg/24 h (range: 3.2-19.8). The mean excretion in 13 boys below 12 years of age was 2.3 μg/24 h (range: 0.4-6.2). The method is especially useful for testosterone determinations in newborn infants. During the first day of life, the testosterone excretion in 7 newborn boys was 0.65 μg/24 h. The corresponding values for 10 girls was 0.11 μg/24 h. (auth)

29662 DETERMINATION OF ALDOSTERONE BY SATURATION ANALYSIS USING BINDING SITES IN MAMMALIAN AND AMPHIBIAN KIDNEY AND AMPHIBIAN BLADDER: PRELIMINARY STUDIES. Vyzantiades, A.; Ekins, R. P.; Slater, J. D. H. (Middlesex Hospital Medical School, London). pp 427-51 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

High-energy aldosterone-binding sites have been identified in the kidney of toads by incubation of tissue homogenates, or separated nuclei, from saline-loaded animals with different concentrations of d(+)-aldosterone-17β and determination of the free/bound ratio. After adjustments for the component of aldosterone binding which is non-specific and largely unaltered by a change of aldosterone concentration (10^{-7}M or more), a plot of b/f versus bound reveals binding sites with equilibrium constants of 4.2×10^8 litres/mole for kidney nuclei and 8.7×10^8 litres/mole for kidney homogenate. Application of the principles for optimum conditions for a saturation analytic procedure suggest that, apart from the problem of non-specific binding, the use of toad kidney would require prohibitively large quantities of tissue. However, high-energy-binding sites have been identified, by a similar method, in the kidney of rabbit, pig, and rat using tritium-labeled aldosterone. These have been localized to the medulla (2.6×10^9 litres/mole for pig and 2.4×10^9 litres/mole for rabbit); the renal cortex of both species showed values which were considerably lower. Separate determinations of the association and dissociation constants for rabbit medulla reveal a figure for the equilibrium constant (2.6×10^9 litres/mole) which is similar to that obtained from the Scatchard plot. Using rabbit medulla tissue fragments, a standard curve was constructed showing a lower detection limit (standard deviation of blank response/slope of response curve) of approximately 15 pg. (auth)

29663 GENERAL ASPECTS OF RADIOIMMUNOASSAY PROCEDURES. Yalow, Rosalyn S. (Veterans Administration Hospital, Bronx, N. Y.); Berson, S. A. pp 455-81 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

A theoretical basis for radioimmunoassay as a special case of competitive radioassay is presented. Special consideration is given to practical problems including methods for separation of free and bound hormone, production and selection of antisera, preparation and protection against damage of suitable labeled antigens, and evaluation of the specificity of the assay. (auth)

29664 IMMUNORADIOMETRIC ASSAY PROCEDURES: NEW DEVELOPMENTS. Miles, L. E. M.; Hales, C. N. (Cambridge Univ., Eng.). pp 483-90 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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The reasons that lead to the development of an assay method involving the use of labeled antibodies for the assay of polypeptide hormones are reviewed. The principal procedures in the method are summarized and individual features of importance discussed in more detail. The limit of sensitivity obtainable using antibodies labeled with one atom of carrier-free ^{125}I per molecule are calculated. This sensitivity has been achieved in practice. The advantage of using labeled antibodies in assays suffering from problems of cross-reactivity are emphasized. (auth)

29665 THE ATTAINMENT OF HIGH SENSITIVITY AND PRECISION IN RADIOIMMUNOASSAY TECHNIQUES AS EXEMPLIFIED IN A SIMPLE ASSAY OF SERUM INSULIN. Albano, Janet; Ekins, R. P. (Middlesex Hospital Medical School, London). pp 491-513 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

Recent controversy has underlined the fundamental confusion surrounding the concepts of assay sensitivity and precision and, in particular, their optimization in radioimmunoassay and other saturation assay procedures. Many formal definitions of sensitivity (e.g., that laid down by the American Chemical Society) express this concept in terms of the slope of the dose response curve; nevertheless, in common usage, the term is normally regarded as a synonym for the detection limit of the measurement technique. However, a technique which is sensitive in the formal sense may not display a low limit of detection, and it is readily demonstrable that, in radioimmunoassay systems in particular, there are circumstances in which increase in the slope of the response curve may lead to an increase in the detection limit of the assay. The authors have based their insulin assay protocols on mathematical principles specifically designed to lead to the minimization of the detection limit. The method depends on the use of (uncoated) charcoal for the separation of free and bound ^{125}I-labeled insulin in incubation mixtures in which insulin-free human serum is used as diluent. The detection limit of the method is approximately 1 pg/ml of incubation mixture, corresponding to roughly 0.25 μU/ml of serum at the serum dilutions used. In a formal comparative study, the method has been shown to be more sensitive, precise and accurate than other methods relying on double antibody or chromatoelectrophoretic separation. The relevance of such factors as high specific activity labeled hormone to the attainment of high sensitivity is discussed. (auth)

29666 PROCEDURES FOR SENSITIVE IMMUNOASSAY. Givol, D. (Weizmann Inst. of Science, Rehovot, Israel). pp 515-24 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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Sensitive radioimmunoassay methods may be applied to small molecules of biological importance, which are non-immunogenic by themselves, such as small peptide hormones (e.g., bradykinin), plant hormones (e.g., indoleacetic acid), nucleotides, and other small molecules. Methods of binding these small molecules, as haptens, to immunogenic carriers by various cross-linking agents are described (dicyclohexylcarbodiimide, tolylene-diisocyanate and glutaraldehyde), and the considerations involved in relation to the methods of binding and the specificity of the antibodies formed are discussed. Some uses of antibody bound to bromoacetyl cellulose as an immunoadsorbent convenient for assay of immunoglobulins are described. Finally, the sensitivity of a ^{14}C-immunoassay method for chemically modified phage is described. This includes methods of binding small molecules (such as the dinitrophenyl group, penicillin, indoleacetic acid) or proteins (such as insulin, immunoglobulins) to phages. Methods of direct chemical conjugation, or an indirect binding via anti-phage Fab, are described. The phage inactivation method by direct plating and its modifications (such as decision technique and complex inactivation) are compared with the more simple end-point titration method. The inhibition of phage inactivation has some advantages as it does not require radioactive material, or expensive radioactive counters, and avoids the need for separation between bound and unbound antigen. Hence, if developed, it could be used as an alternative to radioimmunoassay. (auth)

29667 DOUBLE ANTIBODY METHOD FOR IMMUNOASSAY OF INSULIN. ITS APPLICATION IN POPULATION STUDIES. Welborn, T. A.; Stenhouse, N. S.; Curnow, D. H. (Raine Foundation Medical Statistics Unit, Perth, Australia. Univ. of Western Australia, Perth). pp 525-37 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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The performance of a double-antibody radioimmunoassay technique over a period of two years is described, during which 3300 samples from population studies were analysed for insulin concentration. The method requires safeguards to ensure that complete separation of free from antibody-bound hormone is achieved, thus ^{125}I-labeled gamma-globulin is used in the precise preliminary standardization of precipitating antibody. The dose-response curves for crystalline insulin standards over a range of concentration 0.2 to 16.0 ng (5 to 400 micro-International-Units)/ml are consistently nonlinear, but a close fit is obtained by a cubic function obtained empirically from multiple regression analysis, which also corrects satisfactorily for within-assay drift when large numbers of samples are involved. The coefficient of variation for pooled serum standards repetitively assayed ranged from 10 to 14%. Sources of "between-assay variability" of the serum standards include variable integrity of the labelled insulin and the slope of the standard curve. For quality control material, the need for standards of serum as well as crystalline insulin is stressed. Serum-insulin was measured in 3300 adults of the population of Busselton, approximately 1 h after a 50 g oral glucose load. The concentrations were distributed log-normally. Females had significantly higher one-hour serum-insulin levels than males, and both sexes showed a moderate rise of values with age. Multiple regression analyses revealed that the major determinant of serum-insulin was the blood-sugar level, the independent relationship being such that at one-hour blood-sugar levels exceeding 160 to 180 mg/100 ml, a decline of insulin values occurred. Body-weight had a strong positive association, and height a negative relationship, with the one-hour serum-insulin. Males with coronary heart disease and hypertension showed elevated insulin levels under 60 years of age, whereas ideal males (with obesity, hyperglycaemia and vascular disease excluded) had no rise of serum-insulin with age until 60 years or more. (auth)

29668 INSULIN RADIOIMMUNOASSAY FOR CLINICAL RESEARCH IN PSYCHIATRIC, PANCREATIC, CIRRHOTIC,

AND IRRADIATED PATIENTS. Czerniak, P.; Chlebowski, J.; Kulcar, S.; Boruchowski, Sabina (Tel-Aviv Univ., Israel. Tel-Hashomer Hospital, Israel). pp 549-66 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

A modified Hales-Randle method for insulin radioimmunoassay is described. An insulin response curve was established in normal cases after glucose loading. Pathological changes were then investigated in patients and animals before and after therapeutic, operative, and radiological procedures. Four representative groups of this material are discussed. (1) Psychotic patients (acute and chronic schizophrenics, neurotics and depressives) were examined with the aim of learning about the variable effects produced by insulin shock-therapy, as well as for biochemical diagnosis purposes in psychotics. Highest insulin response curves were found in chronic schizophrenics with improvement after insulin therapy. Schizophrenics without improvement presented different curves. Lowest insulin values were found in acute schizophrenia. Depressives and anxiety neurotics showed insulin tolerance curves similar to those of non-psychotic patients. (2) Pancreatic patients. Special attention was paid to pancreatic carcinoma (insulinoma excepted). In most cases of pancreatic carcinoma a very low and flat insulin tolerance curve was found. The above findings may be of a diagnostic importance in this condition, which is clinically hardly recognized. (3) Liver cirrhotic patients. A special group of shunt operated patients was investigated. The study was performed on eight liver cirrhotics before and after porto-caval or reno-splenal shunt operation. The plasma insulin level was examined in the vena cava, renal and cubital blood. The influence of tolbutamide was analyzed. The normally occurring retention of insulin by normal hepatic tissue was found to be considerably disturbed. Other interesting changes were observed. (4) The plasma insulin level in the radiologically exposed. Experimental and clinical studies were performed, with insulin doses before and after radiation. Whole-body x ray exposure (300 rads) to rats resulted in a rapid lowering of insulin or its disappearance. Recovery was slow. Whole body irradiation in men (3 to 5 rads) produces a quick and short decrease in insulin. Higher doses result in a higher and longer insulin reduction. Carcinomatous patients treated by Ra and ^{198}Au showed plasma insulin changes. The findings seem to be of importance for both diagnosis and treatment of individuals accidentally overexposed or overtreated by ionizing radiations. (auth)

29669 A SPECIFIC SATURATION ASSAY TECHNIQUE FOR SERUM TRIIODOTHYRONINE. Brown, B. L.; Ekins, R. P.; Ellis, S. M.; Reith, W. S. (Middlesex Hospital Medical School, London). pp 569-83 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

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Triiodothyronine (T3) exists in plasma at a concentration of approximately 0.3 μg/100 ml (representing 3 to 5% of the total thyroid hormone present); nevertheless it accounts for more than 20% of the secretion of hormonal iodine. Moreover, because of the relative biological potencies of thyroxine (T4) and T3, the latter compound represents roughly half the biologically effective hormone secreted by the thyroid gland. Serum T3 may, in principle, be assayed by saturation assay techniques relying on serum thyroxine binding protein as the saturable binding reagent, and at least one such method has been published. However, in our own thyroxine assay procedure T4 is approximately eight times more reactive than T3; this implies that, to measure serum T3 to an accuracy of better than 10%, it is essential that not more than 0.05% of serum T4 should remain as a contaminant of T3 extracts. Observations of this kind raise doubts regarding the accuracy of published T3 estimates relying on T.B.P./saturation assay techniques, and underline the desirability of an assay method designed to discriminate more effectively against T4. Specific antibodies directed against T3 which are essentially non-reactive with T4 were obtained. Using these as the saturable reagent, we have devised an assay technique sensitive to approximately 50 pg T3/ml of incubation mixture. Such sensitivity enables normal serum T3 values to be readily measured using starting volumes of blood of about 1 to 2 ml, and the physiological role of this hormone in health and disease to be elucidated. The application of the method to the assay of the iodinated amino acids MIT and DIT and to other similar compounds of a normally nonantigenic nature is also discussed. (auth)

29670 RADIOIMMUNOASSAY OF HUMAN TSH WITH TWO DIFFERENT SYSTEMS. von zur Muehlen, A.; Emrich, D. (Univ., Goettingen, Ger.). pp 585-95 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

Investigations have been undertaken on the radioimmunological determination of human thyrotropic hormone (H-TSH) in plasma with two different systems: with B-TSH as the radioiodine-labeled antigen and antibodies against B-TSH; with H-TSH as the radioiodine-labeled antigen and antibodies against H-TSH (gift of the National Institute of Health, Bethesda, United States of America). Methodological details are presented on the purification of commercially available B-TSH and the production of potent antibodies against it. Highly purified B-TSH and H-TSH were labeled with both ^{131}I and ^{125}I. The preparations were compared under different aspects. Further experiments concerned the conditions of the radioimmunological reaction (time of equilibration, addition of EDTA and HCG). Different methods of separating the free and bound antigen by the double antibody method were studied. In the B-TSH system, standard curves of a sufficient slope were obtained with the International Standard for thyrotropin, bovine, for bioassay (World Health Organization). Using the H-TSH Research Standard A of the National Institute for Medical Research, London, the reaction in the B-TSH system was minimal, probably due to an insufficient cross immunity between H-TSH and B-TSH. For this reason H-TSH could not be detected with the B-TSH system in the serum, not even in patients with primary myxoedema. In contrast with the H-TSH system reproducible standard curves were obtained with H-TSH and diluting the serum from primary hypothyroidism cases. Results are also presented on the determination of H-TSH in different thyroid states. (auth)

29671 MEASUREMENT OF THYROID-STIMULATING HORMONE (TSH) IN VITRO. Kirkham, K. E.; Hunter, W. M.; Jeffery, F. H.; Bennie, J. G. (Medical Research Council, Edinburgh). pp 597-611 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

Many of the methods of assay proposed for the quantitative measurement of human thyroid-stimulating hormone (H-TSH) have encountered major difficulties in relation to sensitivity and specificity. The development of radioimmunoassay techniques for the measurement of H-TSH not only resulted in increased sensitivity over the majority of existing techniques, but led to improvements in specificity and practicability. The purpose of this communication is to compare serum TSH values measured by a method of bioassay in vitro with those obtained by a radioimmunoassay developed using reagents provided by the National Pituitary Agency, United States of America. In the bioassay technique goitrous guinea-pig thyroid tissue is incubated in vitro with ^{131}I and H-TSH during which time the tissue takes up ^{131}I and binds it in organic combination. Measurements of the radioactive content of the culture medium are made before and after the addition of KSCN in order to discharge any ^{131}I present in the tissue as iodide, the difference in count-rate being indirectly proportional to the amount of H-TSH present in the incubation fluid. The method can detect as little as 1.0 mU/100 ml serum. The radioimmunoassay technique used was that described by Odell and Garigan in instructions accompanying the reagents. However, modifications to their technique included the use of antiserum at a final dilution of 1/120,000 and the addition of H-TSH at a final concentration of 0.4 ng/ml to mixtures of antiserum and the standard preparation after an incubation period of five days. After a further five days incubation period, the separation of bound and free ^{131}I-H-TSH was carried out by precipitating the bound hormone with NaCl and ethanol. The lower limit of detection in terms of the H-TSH standard A (MRC) is 5 μU/ml serum (0.5 mU/100 ml). Serum was obtained from children aged one month to 16 years, adults aged 18 to 40 years and 66 to 85 years, patients subjected to either pituitary stalk section on ^{90}Y implantation during treatment for advanced diabetic retinopathy, and one patient suffering from Hashimoto's thyroiditis during periods of suppression by T3 and stimulation by TSH. Assessments of thyroid function were made either by the triiodothyronine uptake test using coated charcoal or by the estimation of the protein-bound iodine content of serum. The correlation between the TSH assay results obtained by the two methods is discussed. (auth)

29672 USE OF RADIOISOTOPES FOR MEASUREMENT OF FOLLICILE STIMULATING (FSH) AND LUTEINIZING (LH) HORMONES, TESTOSTERONE (T), ANDROSTENEDIONE (A), DEHYDROEPIANDROSTERONE (DHEA), PREGNENOLONE (P), CORTISOL, AND SULPHATES IN PLASMA. Saxena, B. B.;

Gandy, Hortense M. (Cornell Univ., New York). pp 613-31 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

Chromatoelectrophoretic radioimmunoassay of FSH and LH with a sensitivity of 0.05 milli-International Units of International Reference Preparation of Human Menopausal Gonadotropin (mIU IRP-HMG) using ^{131}I for iodination, and a double isotope derivative dilution technique for estimation of steroids using ^{14}C-labeled steroid to correct for losses and ^{3}H acetic anhydride to measure mass have been developed. Mean peripheral plasma level of FSH was 21.6 ± 2.05 (SE) with range from undetectable to 68 mIU IRP-HMG/ml during a given 24-hr period; mean LH was 17.4 ± 3.01 (SE), range of 2.5 to 85 mIU. Gonadotropins and steroids were measured in 11 men in consecutive 4-hr samples for 24 hr; lowest levels of hormones were present at midnight. Mean 8 a.m. values for FSH and LH were 47 ± 3.7 (SE) and 51 ± 6.8 (SE) mIU/ml respectively; values for T, DHEA, A and P were 0.52 ± 0.06 (SE), 0.60 ± 0.06 (SE), 0.15 ± 0.006 (SE) and 0.12 ± 0.009 (SE) μg/100 ml respectively. Morning values for FSH and LH were 60 to 70% higher than evening values. Morning values of steroids were significantly higher than evening levels. (auth)

29673 RADIOIMMUNOASSAY OF POLYPEPTIDE HORMONES IN ANTIBODY-COATED TUBES. Catt, K. J.; Tregear, G. W.; Burger, H. G. (Monash Univ., Melbourne). pp 633-46 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

The procedure of radioimmunoassay has been facilitated by the use of solid-phase antibody, allowing rapid and complete separation of bound and free tracer by a simple washing step. A further improvement of the technique has been achieved by the use of assay tubes coated internally with specific antibody. This form of solid-phase radioimmunoassay is based upon the observation that a wide variety of plastic tubes will adsorb appropriate quantities of antibody to allow assay of antigen by competitive binding with tracer for the surface of the assay tube. In practice, polystyrene tubes of convenient size to fit an automatic γ spectrometer are coated with antibody by addition of a suitably diluted antiserum for 2 to 16 hr. After washing, the coated tubes are used for assay by addition of samples and standards together with ^{125}I-tracer antigen followed by incubation at 37°C for one or two days. During this period, ^{125}I-tracer becomes attached to the antibody-coated tube surface in inverse proportion to the mass of unlabelled antigen present in the tube. After incubation, the tubes are washed again and counted to determine the bound tracer attached to the tube surface. Antigen concentration in plasma samples is then read off the standard curve constructed from the tube counts of the assay standards, or computed from the slope of a linearized reciprocal form of the standard curve. The method has been shown to be applicable to the assay of a wide variety of peptide hormones, and has several advantages in addition to simplicity. The entire procedure is performed within the assay tube, and no centrifugation or other formal separation procedure is required. The level of circulating hormones can be readily determined, and high specific activity tracer is not required. Sensitivity and reliability are comparable with those of more complex assay procedures, and coated tubes can be used for assay after prolonged storage. The method has been particularly useful for routine assays of human growth hormone and luteinizing hormone, allowing rapid and reliable assessment of pituitary hormone secretion in hypopituitarism, acromegaly, dwarfism and gonadal disturbances. Similar procedures may be of value in saturation analysis assays for steroids and other molecules with specific binding proteins. (auth)

29674 RADIOIMMUNOASSAY FOR ANGIOTENSIN-II ADJUSTED FOR ESTIMATION OF RENIN CONCENTRATIONS IN NON-PRE-TREATED PLASMA. Poulsen, K. (Inst. for Experimental Medicine, Copenhagen). pp 647-58 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

Details are described of a radioimmunoassay for angiotensin-II modified to replace the bioassay for angiotensin in estimation of renin in blood. High titre antibodies with association constants of 7×10^{9} to 3×10^{10} litre/mole were obtained in rabbits, using carbodiimide condensation of angiotensin-II to gamma globulin. The radioimmunoassay is adapted to be performed in a relatively high concentration of plasma, always, however, in the same concentration of the same plasma pool preparation. Radioimmunoassay performed in this medium enables an estimation to be made of the reaction medium of a renin assay, the principle of which is characterized by a precisely determined concentration of angiotensinogen during the reaction, controlled activity of the converting enzyme, and complete abolition of the influence of the angiotensinases. Adjusting to high precision rather than high sensitivity, the angiotensin-II formed as the final product by the enzyme reactions is measured with an accuracy of ±4% S.D. in the range 0.5 to 2 ng; 300 μl serum allow an easy procedure in measurement of plasma renin concentrations with gentle and few treatments. The sensitivity limit is 10 times lower than the mean of the normal range. The accuracy of the whole assay is ±6% S.D. (auth)

29675 A MODEL FOR PREDICTION OF CONFIDENCE LIMITS IN RADIOIMMUNOASSAYS AND COMPETITIVE PROTEIN BINDING ASSAYS. Rodbard, D.; Cooper, J. A. (National Insts. of Health, Bethesda, Md.). pp 659-74 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

Data processing for radioimmunoassays and competitive-protein binding assays has traditionally involved manual, graphical interpolation of potency estimates for unknowns from nonlinear standard curves without estimation of 95% confidence limits. By suitable choice of response variable, and use of theoretically justified transformations, we have obtained empirical linearization of the dose response curve, and have developed a model for prediction of the error of the response variable for any position on the dose response curve using computer calculations. This model is based on a synthesis of variance: estimation of the individual components of variance due to pipetting of reagents, counting errors and misclassification errors. This model has been tested and is compatible with available data. The model makes it possible to use weighted regression analysis to obtain 95% confidence limits for the curve and for potency estimates. This makes it possible to automate the processing of radioimmunoassay data and to predict conditions for optimum sensitivity and precision. These methods were applied to radioimmunoassays for human growth hormone and human luteinizing hormone, and to protein binding assays for progesterone and 17 α-hydroxy-progesterone. (auth)

29676 STANDARDS AND REFERENCE REAGENTS FOR RADIOIMMUNOASSAY. Cotes, P. Mary (National Inst. for Medical Research, London). pp 675-81 of In Vitro Procedures With Radioisotopes in Medicine. Vienna; International Atomic Energy Agency (1970).

From Symposium on In Vitro Procedures with Radioisotopes in Medicine, Vienna, Austria. See STI/PUB-237; CONF-690949.

A stable standard is necessary for radioimmunoassay quantitation; it should be identical with the molecular species being estimated and diluted in a medium similar to that of the samples for assay. It cannot be assumed that a peptide hormone will be present in the same form in a gland extract, plasma, or urine so, for some hormones, it may be necessary to use separate standards for assay of samples from different sources. For comparison of results between laboratories, common standards must be used. In some instances these common standards cannot be replaced by the various highly purified preparations of natural or synthetic polypeptide hormones available to each investigator since preparations may differ with respect to specific biological activity, content of precursor, or degraded molecules, moisture content, and stability. Whereas it may not be necessary to use a highly purified preparation as a standard; well-characterized highly purified preparations of peptides with known biological activities are necessary to establish the specificity of assay systems. The preparation of WHO standards and reference preparations intended for immunoassay are described, and assessment of their suitability and stability discussed. (auth)

29677 MORPHINE: RADIOIMMUNOASSAY. Spector, Sydney (Roche Inst. of Molecular Biology, Nutley, N. J.); Parker, Charles W. Science; 168: 1347-8(12 Jun 1970).

The development of a radioimmunoassay for morphine is described. The hapten morphine is made antigenic by coupling it to a protein at the phenolic group of the molecule. Extremely low concentrations of morphine (0.5 nanogram) can be measured by this assay procedure. (auth)

29678 GONADOTROPINS 1968. Proceedings of the Workshop Conference Held at Vista Hermosa, Mor., Mexico, June 24–26, 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968. 579p. (CONF-680660).

The proceedings of a workshop conference on gonadotropins is described; the conference was arranged according to topics.

These were: chemistry of gonadotropins, biology of gonadotropins, immunologic assay of human and animal gonadotropins, measurement of gonadotropic activity by radioimmunoassay, use of standards in gonadotropin assay, gonadotropin therapy studies in female subjects, and gonadotropin therapy studies in male subjects. Individual papers under each topic were followed by discussion notes. Separate abstracts for 16 of the 56 papers were prepared for inclusion in NSA. (C.O.)

For abstracts of individual papers see: 29679–29694.

29679 THE INFLUENCE OF IODINE ISOTOPIC COMPOSITION ON HORMONE LABELLING. Levy, A.; Gvion, R.; Eshkol, A.; Lunenfeld, B. (Israel Atomic Energy Commission, Negev. Tel-Hashomer Government Hospital, Israel). pp 251-3 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

The influence of the ratio of inactive to active iodine (^{131}I) on labeling yield is discussed. The high specific activity of iodine was found to be crucial in production of immunochemically intact labeled hormone. Data substantiated that iodine must be taken into consideration in hormone labeling; variations in the period of target irradiation, the separation process, and the storage time were considered crucial factors. The effects of these factors were analytically evaluated; results are presented in tabular form. (C.O.)

29680 SOLID PHASE ANTIBODY SYSTEMS. Crooke, A. C.; Butt, W. R.; Lynch, S. S. (United Birmingham Hospitals, Eng. Midland Hospital for Women, Birmingham, Eng.). pp 255-62 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

A radioimmunoassay for human pituitary follicle stimulating hormone (FSH) in which the antibody is attached to a solid phase for the separation of free and bound antigen is described. The sensitivity of the method to FSH was ~0.5 mIU/ml. The method was applied to kaolin extracts of urine and the correlation with bioassay was so good that it did not appear that any urinary material was extracted which interfered with the assay. Interference from luteinizing hormone (LH) and human chorionic gonadotropin (HCG) was not thought to be of significance. It was concluded that the solid-phase antibody method was an efficient, convenient, and simple technique for determination of FSH levels. (C.O.)

29681 RADIOIMMUNOASSAY OF HUMAN CHORIONIC GONADOTROPIN (HCG) AND HUMAN LUTEINIZING HORMONE (LH) USING INSOLUBLE ANTIBODIES. Donini, S.; D'Alessio, I.; Donini, P. (Instituto Farmacologico Seroni, Rome). pp 263-72 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

A method for the radioimmunoassay of human chorionic gonadotropin (HCG) and luteinizing hormone (LH), based on competitive inhibition of the binding between ^{125}I-HCG and anti-HCG serum insolubilized by polymerization, is described. Good agreement between the bioassay and the radioimmunoassay was found independent from the FSH/LH ratio and from the purity grade of the preparation tested. The bioassay/radioimmunoassay ratio ranged from 0.91 to 1.23 mIU/ml for LH and from 0.65 to 1.18 for HCG. It was concluded that findings obtained with the method described were much higher than those obtained by biological assays and that the method could be applied to radioimmunoassay of other hormones. (C.O.)

29682 SPECIFICITY, SENSITIVITY, AND PRECISION OF A RADIOIMMUNOASSAY FOR FSH. Taymor, Melvin L.; Aono, Toshihiro (Harvard Medical School, Boston. Peter Bent Brigham Hospital, Boston). pp 273-81 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

The specificity, sensitivity, and precision of a radioimmunoassay for follicle stimulating hormones (FSH) was determined using an absorption technique. Cellulose-acetate studies pointed out the need for removal of non-specific antibodies such as anti-LH. When the undiluted antiserum was absorbed with progressively increasing amounts of HCG prior to use, the relation between immune and bioassay improved. When HCG was added to a level of 1385 IU/ml of antiserum no cross absorption lines appeared between the absorbed antiserum and LH. More complete absorption was obtained by using 10 IU of HCG in each tube during the assay. The precision of the FSH assay system is presented in tabular form. (C.O.)

29683 COMPARISON OF RADIOIMMUNOASSAYS OF FSH AND LH IN DIALIZED, UNDIALIZED, AND EXTRACTED URINE WITH BIOASSAY METHODS. Stevens, Vernon C. (Ohio State Univ., Columbus). pp 283-9 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

The effect of salt concentrations on a radioimmunoassay and bioassay system for follicle stimulating hormones (FSH) and luteinizing hormones (LH) in urine was investigated. Unprocessed urine, dialyzed urine, and urine extracts were used. A significant inhibition of the binding of tracer antigen to antisera was observed by the addition of NaCl in both systems. Data indicated that radioimmunoassays of unprocessed urine for FSH and LH did not provide meaningful excretion values. Extraction by the kaolin-acetone method yielded material suitable for meaningful estimates by radioimmunoassay. Simple dialysis of urine samples produced dose response slopes parallel to that of the standard hormone. It was concluded that it remains to be seen whether dialysis was sufficient purification of the urine to remove interfering substances before performing radioimmunoassay. (C.O.)

29684 RADIOIMMUNOLOGIC STUDIES WITH MURINE, BOVINE, OVINE, AND PORCINE LUTEINZING HORMONE. Niswender, Gordon D.; Midgley, A. Rees Jr.; Reichert, Leo E. Jr. (Univ. of Michigan, Ann Arbor. Emory Univ., Atlanta). pp 299-306 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

The extent of species specificity present in a radioimmunoassay (RIA) system was determined. The development of a highly sensitive RIA for rat luteinizing hormone (LH) that uses a unique anti-ovine LH serum and radioiodinated ovine LH is reported. Dose response curves with LH from cattle, man, pigs, rats, sheep, and human chorionic gonadotropin (HCG) and pregnant mare serum gonadotropin (PMS) were run in four different RIA systems. The effects of serum and antibody content were determined in the ovine rat LH RIA. The relative potency of bovine pituitary preparations with widely varying ratios of LH to follicle stimulating hormone (FSH) and LH to thyroid stimulating hormone (TSH) was determined in the bovine LH RIA and the ovine LH RIA. A similar comparison was also made between relative potencies of porcine pituitary preparations in a porcine LH RIA and the ovine LH RIA. Results are presented in graphic and tabular form. It was concluded that it is possible to use a unique anti-ovine LH serum, ovine-LH-^{131}I and appropriate standards as the basis for a single RIA to quantitate bovine, ovine, porcine, and rat LH. (C.O.)

29685 RADIOIMMUNOLOGIC STUDIES OF RAT LH. Midgley, A. R. Jr.; Gay, V. L.; Caligaris, L. C. S.; Rebar, R. W.; Monroe, S. E.; Niswender, G. D. (Univ. of Michigan, Ann Arbor). pp 307-12 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

Changes observed in pituitary glands and sera of rats in relation to radioimmunoassay (RIA) studies are summarized. The two methods for RIA for rat luteinizing hormone (LH) used anti-rat LH serum and purified-labeled rat LH and a highly selected anti-ovine LH serum and purified labeled ovine LH. Topics investigated were response of LH levels to exogenous steroids, assessment of LH releasing activity in hypothalamic extracts, changes in serum LH following castration, content of LH in the rat during the estrous cycle, serum LH in immature female rats treated with pregnant mare's serum, content of LH before and after delivery, and disappearance rate of LH in intact and castrated rats. (C.O.)

29686 SOLID-PHASE RADIOIMMUNOASSAY OF OVINE, BOVINE, AND MURINE LUTEINIZING HORMONE. Amoss, Max S. Jr.; Guillemin, Roger (Baylor Univ., Houston, Tex.). pp 313-22 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

The protocol used in a simple, routine, solid phase radioimmunoassay for rat LH, sheep LH and bovine LH is described in detail. Experiments are reported in which the immunoassay

for LH is more than 1000 times more sensitive than the bioassay now used by most investigators. The absence of cross reactions between FSH or prolactin and LH is shown and the ability to decrease the cross reaction with TSH by absorption of the antiserum with that hormone is reported; it is envisioned that a finite amount of TSH will be found, which will bring about the precipitation of all of the TSH specific antibodies present. Similarities in both biological and immunochemical potencies of several ovine LH preparations have been observed; a linear relation between the amount of serum tested in the immunoassay and the concentration of LH is reported. The use of an antiserum to ovine LH to determine murine LH is also reported; this heterologous system is shown to be more sensitive than the homologous system using the anti-MLH antisera presently available. The solid-phase radioimmunoassay as described offers a simple, sensitive and reliable assay for the determination of LH in biological fluids. (auth)

29687 RADIOIMMUNOASSAY OF FSH AND LH IN HUMAN SERUM: THE EFFECTS OF AGE, AND INFUSION OF SEVERAL POLYAMINES IN MALES. Ryan, Robert J.; Faiman, Charles (Mayo Clinic, Rochester, Minn.). pp 333-7 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

Observations on content of human follicle stimulating hormone (FSH) and luteinizing hormone (LH) in the serum of healthy young and old adult males and the effects of administration of arginine, histamine, and putrescine on release of these hormones are reported. Specific radioimmunoassays for FSH and LH were used. The 95% confidence limits for serum LH were ±24% and for FSH ± 26%. None of the polyamines induced a significant release of FSH or LH in man when administered in a peripheral vein. (C.O.)

29688 RADIOIMMUNOASSAY OF FSH AND LH IN BODY FLUIDS. Saxena, B. B.; Gandy, H. M.; Peterson, R. E. (Cornell Univ., New York). pp 339-45 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

The radioimmunoassay of human pituitary follicle stimulating hormone (FSH) and luteinizing hormone (LH) described for estimation of gonadotropins in plasma was used to study FSH and LH in urine, in plasma following administration of chlorophene citrate, during pregnancy and parturition and in newborn, and diurnal variation in men. Brief discussions are presented of the results of each area investigated. Data are presented in graphic and tabular form. (C.O.)

29689 SERUM LEVELS OF FSH AND LH BY RADIOIMMUNOASSAY. Taymor, Melvin L.; Aono, Toshihiro; Pheteplace, Carolyn (Harvard Medical School, Boston. Peter Bent Brigham Hospital, Boston). pp 349-53 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

The day to day content of follicle stimulating hormone (FSH) and luteinizing hormone (LH) in human blood serum, the diurnal variation in the content of these hormones, and the content of FSH and LH in the blood during the menstrual cycle were investigated using a radioimmunoassay system. There was no significant day to day variation; there was a tendency to lower afternoon levels of FSH and no demonstrable change in LH levels; a distinct pattern was noted for FSH and LH levels during the menstrual cycle. The FSH level was relatively high in the early and midportion of the follicular phase and there was a significant lowering of FSH levels on the day prior to the LH peak; FSH then rose again. The midcycle FSH rise usually came a day after the LH peak. Levels of FSH were varied during the follicular phase. (C.O.)

29690 EFFECT OF ORAL CONTRACEPTIVES ON PLASMA FOLLICLE STIMULATING HORMONE. Cargille, C. M.; Ross, G. T.; Rayford, P. L. (National Cancer Inst., Bethesda, Md.). pp 355-60 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

Plasma follicle stimulating hormone (FSH) levels were measured by radioimmunoassay in samples taken daily in eight women during control menstrual cycles and cycles in which they received Enovid E. The pattern of FSH observed during a normal menstrual cycle was obliterated in women receiving Enovid E. It was concluded that the contraceptive efficacy of the regimen inheres primarily in suppression of pituitary secretion of gonadotropins with consequent inhibition of ovulation. (C.O.)

29691 PLASMA LUTEINIZING HORMONE LEVELS IN MALES ACUTELY EXPOSED TO HIGH ALTITUDE. Sobrevilla, Luis A.; Midgley, A. Rees (Univ. Peruana Cayetano Heredia, Lima. Univ. of Michigan, Ann Arbor). pp 367-71 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

Ten volunteer healthy seamen born and reared at sea level were removed to an altitude of 14,000 ft (mean barometric pressure 445 mm Hg) and retained there for four weeks. Plasma luteinizing hormone (LH) levels were determined by radioimmunoassay for both altitudes. A significant drop ($p < 0.05$) of approximately 16% occurred on the morning of the third day; by the seventh day LH levels returned to normal. The effect of these variations on seminal changes are discussed. (C.O.)

29692 SERUM HLH LEVELS IN OVARIAN AND SYSTEMIC VEIN BLOOD BY RADIOIMMUNOASSAY. Naftolin, F.; Espeland, D.; Tremann, J. A.; Dillard, E. A.; Paulsen, C. A. (Univ. of Washington, Seattle. Public Health Service Hospital, Seattle). pp 373-9 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

In nine of twelve women studied, the difference between systemic and ovarian venous levels of luteinizing hormone (LH) was greater than double the error of the method (radioimmunoassay). A consistent lowering of LH concentration in blood leaving the ovary was found. No pattern relating to age, time of cycle, or treatment with estrogen-progestin mixtures could be defined since the relative decrease in ovarian venous LH levels was similar in all but one of the subjects studied. The one exception was a 37-year-old multigravid female in good health who had uterine fibroids and menorrhagia. Five months prior to surgery she had had a carcinoma of the breast with axillary node metastases removed; she was tumor free at the time of laparotomy. None of the patients had a positive history, physical signs, or laboratory tests indicative of endocrine abnormality. All levels of LH were in the normal range. It was concluded that a consistent and significant lowering of LH in ovarian venous serum (11-38%) constitutes preliminary evidence that LH is metabolized by the ovary in women. (C.O.)

29693 REPORT OF THE NATIONAL PITUITARY AGENCY COLLABORATIVE STUDY OF THE RADIOIMMUNOASSAY OF FSH AND LH: CONSIDERATION OF STANDARDS. Albert, A. (Mayo Clinic, Rochester, Minn. Mayo Graduate School of Medicine, Rochester, Minn.). pp 393-400 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

Principles governing the appropriate use of standards in assays, whether the assays are biological, chemical, immunological, or microbial are discussed in relation to radioimmunoassay standards for human follicle stimulating hormone and luteinizing hormone; the similarity and stability of materials selected as standards were included as well as the unitage proposed for a standard and ways of reporting values. (C.O.)

29694 CORRELATION BETWEEN BIOASSAY AND IMMUNOASSAY OF HUMAN LUTEINIZING HORMONE. Odell, W. D. (Harbor General Hospital, Torrance, Calif.); Swerdloff, R. S.; Reichert, L. E. pp 401-2 of Gonadotropins 1968. Rosemberg, Eugenia (ed.). Los Altos, Calif., Geron-X, Inc., 1968.

From Conference on Gonadotropins, Vista Hermosa, Mex. See CONF-680660.

The correlation between immunoassay and bioassay potency estimates using pituitary gonadotropin preparations (LH) was investigated. Results are presented in tabular form. Bioassay and radioimmunoassay (RIA) potency estimates obtained for urinary preparations using a urinary reference preparation were in agreement; bioassay and RIA potency estimates obtained for LH using a pituitary reference preparation were in agreement; and bioassay potency estimates of LH were smaller than RIA potency estimates when a urinary preparation was used. It was concluded that the second international reference preparation of human menopausal gonadotropin that was used in the investigations may not be a suitable reference preparation for quantitating pituitary materials. (C.O.)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 29218, 29219, 29222, 29446, 29725, 29786, 29790–29793, and 29812.

29695 (UCD-472-116, pp 33-8) WHOLE-BODY ^{90}Sr RETENTION AND DISTRIBUTION IN TRABECULAR AND CORTICAL BONE OF BEAGLES. Della Rosa, R. J.; Goldman, Marvin (California Univ., Davis. Radiobiology Lab.).

Post-administration ^{90}Sr retention based on whole-body counting data was fit to an expression using the sum of two exponentials; short (0.3 yr) and long term (~15 yr) components were estimated. The latter represented about 80% of the maximum body burden acquired after 1.5 yr on the ^{90}Sr diet. The half-period of ^{90}Sr in individual bones, trabecular corings, and cortical bone relative to teeth at different times post-feeding was estimated as 15 yr for cortical bone and about 1.3 yr for trabecular bone. There was little selective loss of label from teeth. (auth)

29696 (UCRL-18793, pp 43-51) CLINICALLY APPLICABLE FLUORO-KINETIC METHOD FOR BONE BLOOD FLOW DETERMINATION. Van Dyke, Donald C.; Naets, Jean-Pierre (California Univ., Berkeley. Lawrence Radiation Lab.).

Because the rapid initial clearance of fluoride from blood is dominated by urinary excretion and uptake by bone, uptake by bone can be computed from information on blood clearance and urinary appearance during the first hour after intravenous administration. Since the extraction of fluoride by bone is virtually complete on a single passage, bone uptake in the initial period can be converted to total skeletal blood flow. The short-lived isotope of fluorine, ^{18}F, is ideal for clinical application to the kinetic determination of blood flow to the skeleton. Study of normal rats and dogs by this method indicates that the effective circulation to the skeleton is approximately 3% of cardiac output. Values from 1.9 to 8.5% of cardiac output going to bone have been found in nine patients with different diseases associated with vascular or skeletal abnormalities. Application of this technique should provide better insight into the relationship of bone blood flow to a variety of disturbances involving the skeleton, and should be a valuable aid in differential diagnosis once the characteristic findings in different disease conditions have been established. (auth)

29697 (UCRL-18793, pp 64-72) LOCALIZATION OF ^{58}Co AND ^{65}Zn HEMATOPORPHYRIN COMPLEXES IN CANINE LYMPH NODES. Fawwaz, Rashid A.; Winchell, H. Saul; Frye, Frederick; Hemphill, William P.; Lawrence, John H. (California Univ., Berkeley. Lawrence Radiation Lab.).

Following the intravenous administration of ^{58}Co-hematoporphyrin to a series of dogs, the lymph nodes, kidneys, and liver showed the highest uptake of radioactivity. Radiosensitive tissues such as the duodenal mucosa and the bone marrow showed much less concentration of radioactivity. These findings, coupled with the marked vulnerability of the lymph cells to irradiation, suggest the possibility of selective lymph-node irradiation, using appropriate radioisotopic metallo-hematoporphyrins. (auth)

29698 (UCRL-18793, pp 73-9) EVALUATION OF ^{111}Ag, ^{113}Sn, ^{90}Yt, AND ^{109}Pd HEMATOPORPHYRIN COMPLEXES FOR SELECTIVE LYMPHATIC IRRADIATION. Fawwaz, Rashid A.; Winchell, H. Saul; Winstead, Meldrum B.; Armaly, Gery C.; Hemphill, William P.; Lawrence, John H. (California Univ., Berkeley. Lawrence Radiation Lab.).

Although ^{111}Ag- and ^{113}Sn-hematoporphyrin complexes failed to show any significant accumulation in lymph nodes, ^{109}Pd (a pure β^- emitter with a 13-hour half-life) complexed with hematoporphyrin showed four times as much accumulation in mesenteric lymph nodes as in bone marrow of dogs and 12 times as much accumulation in mesenteric lymph nodes as in duodenal mucosal cells. Compared with ^{58}Co-hematoporphyrin, ^{109}Pd-hematoporphyrin showed less uptake by mesenteric lymph nodes and greater uptake by bone marrow. These differences, however, were not statistically significant. The mesenteric lymph nodes showed greater uptake of ^{109}Pd- and ^{58}Co-hematoporphyrin than did nonmesenteric lymph nodes. This may be a function of antigenic stimulation. (auth)

29699 (UCRL-18793, pp 86-8) SYNTHESIS OF ^{11}C-CARBOXYLIC ACIDS AND THEIR USE IN ORGAN VISUALIZATION. Winstead, Meldrum B.; Winchell, H. Saul; Fawwaz, Rashid A.; Armaly, Gery C. (California Univ., Berkeley. Lawrence Radiation Lab.).

The synthesis and use of ^{11}C aliphatic, aromatic, and heterocyclic carboxylic acids are reported. Those carboxylic acids containing a benzene or heterocyclic ring were primarily conjugated in the liver and kidneys and excreted in the kidneys; these events allowed for renal visualization. 1-Naphthoic acid, p-chlorobenzoic acid, and 2-thiophenecarboxylic acid were excluded from the brain and did not concentrate in salivary glands or mucosa of the nasal sinuses; it was suggested that these compounds may be useful for brain tumor visualization. Carbon-11-labeled aliphatic acids (butyric, pentanoic, and octanoic acids) were in general slowly metabolized and did not show discrete organ localization; pentanoic acid was excreted in the bile and allowed for gall bladder visualization. Data on the ^{11}C-labeled carboxylic acids that were synthesized and their temporal distribution in the dog are presented in tabular form. (C.O.)

29700 (UCRL-50639) BIOLOGICAL CONSIDERATIONS OF NONNUCLEAR INCIDENTS INVOLVING NUCLEAR WARHEADS. Langham, Wright H. (California Univ., Livermore. Lawrence Radiation Lab.). Apr 1969. 38p. Dep. CFSTI.

Physical, chemical, and radiological properties of materials used in nuclear warheads are presented. Prediction of exposure and contamination levels and an evaluation of biological consequences of nonnuclear incidents are summarized. Physiological properties of ^{239}Pu are considered with regard to skin absorption and subsequent deposition and retention, gastrointestinal absorption and deposition, inhalation and deposition, and general environmental uptake. Toxicological properties are discussed from the standpoint of effects from skin deposition and absorption, effects from ingestion and absorption from the intestine, and effects from inhalation, lung deposition, and translocation. Relevant human experience is reviewed with regard to bone tumors in radium cases, bone doses in thorotrast cases, lung doses in thorotrast cases, lung tumors in uranium miners, liver tumors in thorotrast cases, and human experience with plutonium. Physiological properties of tritium are considered from the standpoint of skin absorption and subsequent distribution, ingestion and absorption from the intestine, and inhalation and absorption from the lung. Physical, chemical, and toxicological properties of beryllium are discussed. Other topics discussed are predicted $^{239}PuO_2$ exposures from continuous occupancy of a contaminated area; biological consequences from plutonium exposures; and a feasibility of plutonium decontamination of hard surfaces and land areas. (H.L.W.)

29701 THOROTRAST DAMAGE. REVIEW AND REPORT OF 3 CASES. Barousch, R. (Medizinische Abteilung des Krankenhauses der Stadt, Vienna). Wien. Med. Wochenschr.; 119: 681-5(11 Oct 1969). (In German).

The case histories of three patients are given who received thorotrast injections several decades ago. The slow elimination of ^{232}Th is discussed. Preferentially, the radioisotope accumulates in the reticuloendothelial system, and dose calculations for liver, spleen, and bone marrow are given. The carcinogenic properties of ^{232}Th are also discussed. (H.B.G.)

29702 EFFECTS OF DOPAMINE, GAMMA-AMINOBUTYRIC ACID, AND 5-HYDROXYTRYPTAMINE ON INCORPORATION OF ^{32}P INTO PHOSPHATIDES IN SLICES FROM THE GUINEA PIG BRAIN. Hokin, Mabel R. (Univ. of Wisconsin, Madison). J. Neurochem.; 17: 357-64(1970).

Uptake of ^{32}P into various phosphatides was studied in slices from the brain of guinea pigs. Dopamine at a concentration of 0.001 mM strongly inhibited the incorporation of ^{32}P, especially into the corpus striatum. Gamma-aminobutyric acid at a concentration of 10 mM also significantly decreased ^{32}P incorporation. 5-Hydroxytryptamine at a concentration of 1 mM strikingly enhanced incorporation of ^{32}P up to four times the normal value. It was concluded that increased incorporation of ^{32}P into phosphatides was associated with excitatory nerve transmission while inhibition of incorporation of ^{32}P was correlated to inhibitory neurotransmission. (H.B.G.)

29703 STRUCTURAL ALTERATIONS OF THE MUREIN SACCULUS OF SPIRILLUM SERPENS AFTER TREATMENT WITH URANYL ACETATE. Preusser, H.-J. (Technische Hochschule, Darmstadt, Ger.). Arch. Mikrobiol.; 68: 150-64(Oct 1969). (In German).

Highly purified murein sacculi from cells of Spirillum serpens were studied by electron microscopy after treatment with a 0.012 M uranyl acetate solution, buffered at pH 4.5. This treatment causes a drastic increase in contrast of the sacculi and a progressive contraction along the longitudinal axis, eventually resulting in the appearance of electron-dense rings. Contraction of the sacculi perpendicular to the longitudinal axis is comparatively small. These observations and also the formation of separate ring-shaped sacculus segments suggest a certain anisotropic arrangement of the murein lattice within the sacculus. Treatment of murein sacculi with uranyl acetate at pH 2.0 results in a complete breakdown of the fine structure. These effects are discussed in view of penetration of the rigid layer by macromolecules as well as of structure and dimensions of the murein layer in ultrathin sections of UO_2^{++}-stained bacterial cell walls. (auth)

29704 DEVELOPMENT OF SOME RADIOISOTOPE PROCEDURES FOR MEASURING WATER MOVEMENT IN TREES. Owston, Peyton W.; Smith, James L.; Halverson, Howard G. (Dept. of Agriculture, Berkeley, Calif.). Isotop. Radiat. Technol.; 7: 396-401(Summer 1970). (TID-25136).

Water transpired by trees greatly reduces the water available to streams from forested watersheds. An attempt is being made in the Sierra Nevada of California to measure this passage of water through individual trees by radioactive tracers. Initial experiments were conducted with lodgepole pine (Pinus contorta Dougl.) and red fir (Abies magnifica A. Murr.) during different seasons of the year. Phosphorus-32 was injected into standing trees through small lateral roots. The rate of water movement was determined by two measurements: the path of movement was monitored outside the bark with a portable scintillation detector and the cross-sectional pattern of movement was determined by autoradiographing transverse disks of stems. Rates of daytime isotope movement for both species ranged generally from 20 to 70 cm/hr during the summer. Movement in winter averaged 0.3 to 1.3 cm/hr in red fir. The fastest rates of ascent, 1.5 to 2.0 m/hr, were measured in early spring when as much as 12 ft of snow lay on the ground. Most of the movement occurred in the outer sapwood, but some radioactivity was found 6 to 8 cm deep at times of rapid ascent. (auth)

29705 SUBCELLULAR DISTRIBUTION OF ^{51}Cr AND CHARACTERIZATION OF ITS BINDING SITES IN HUMAN PLATELETS. Steiner, Manfred; Baldini, Mario (Memorial Hospital, Pawtucket, R. I. Brown Univ., Providence). Contract AT(30-1)-3590. Blood; 35: 727-39(May 1970).

Subcellular fractionation of human platelets labeled with ^{51}Cr sodium chromate was utilized to study distribution and characterization of the ^{51}Cr binding sites in these cells. The cytoplasmic fraction of the platelets contained the major portion of the radioactivity while microsomal and mitochondrial fractions played a minor role in the binding of chromate. The stromal sediment had approximately one third of the total radioactivity. Only about 20% of the ^{51}Cr taken up by the platelets was in a free ionic form and was in the cytoplasmic fraction. The major portion of the ^{51}Cr in the platelets was bound to nucleotides in the platelet cytoplasm. Nucleotides of the α-granules had no radioactive chromate. Hypertonic media and platelet antiserum produced marked release of ^{51}Cr from the platelets, whereas aggregating agents produced none. In physiological conditions, elution of ^{51}Cr from labeled platelets is very limited because there is only little ^{51}Cr in free ionic form in the cells. Release of considerable amount of ^{51}Cr from the platelets can occur only in case of cell damage with release of nucleotides from the cytoplasmic pool. This was seen with hypertonic solutions and with platelet antibody. Platelet degranulation, as it occurs with aggregating agents, is not associated with release of ^{51}Cr since the granular pool of nucleotides is not labeled by this compound. (auth)

29706 ^{90}Sr IN CHILDREN'S TEETH. Benech, Claudio; Franchi, Carlos M. (Instituto de Investigacion de Ciencias Biologicas, Montevideo). Arch. Soc. Biol. Montevideo; 27: Special No., 26-9(1969).

Approximately 250 teeth of children were analyzed for calcium content and ^{90}Sr activity. Data were compiled in one table. The levels found were in general agreement with the ^{90}Sr content of milk consumed in Montevideo. The values were significantly lower than those reported for St. Louis, Mo., in accordance with differences in the ^{90}Sr levels of local diets. (H.B.G.)

29707 CONCENTRATION FACTORS FOR STRONTIUM AND CESIUM IN FISH OF THE LAKES IN THE REGION OF VARESE (NORTHERN ITALY). De Bortoli, M. (EURATOM, Ispra, Italy); Gaglione, P.; Malvicini, A.; Polvani, C. G. Fis. Sanit. Prot. Radiaz.; 12: 324-31(Oct-Dec 1968). (RT-PROT-(69)27).

The authors followed for seven years the seasonal behavior of ^{90}Sr and ^{137}Cs concentration in waters and fishes of the four lakes in the region of Varese (Northern Italy), fish species considered are Perca fluviatilis, Scardinius erythrophtalmus, Eupomotis gibbosus. The lakes are Maggiore, Varese, Comabbio and Monate. The concentration factors obtained are rather high owing to the low salt concentration in the lake waters. The authors discuss the values of the observed concentration factors and their trend in seasons and years, with reference to the varying concentration of activity in the lake waters. Using the observed concentration factors, an evaluation is made of the real concentration factors. A comparison is made of the concentration factors of ^{137}Cs and ^{90}Sr and for non-radioactive elements. (auth)

Radiation Effects

Refer also to abstracts 29858, 29885, 29901, and 29906.

29708 (UCD-472-116, pp 93-5) EFFECT OF X-IRRADIATION ON DNA POLYMERASE AND THYMIDINE KINASE ACTIVITIES IN TRANSFORMED LYMPHOCYTES. Huff, Sally D.; Klein, A. Kimiko; Nix, Nancy (California Univ., Davis. Radiobiology Lab.).

Comparative effects of 300 R x irradiation on several enzymes involved in nucleic acid synthesis are being studied, using phytohemagglutinin-stimulated mononuclear cells from peripheral blood as a model system. DNA polymerase appears more sensitive than thymidine kinase. The timing of irradiation in reference to the timing of the appearance of active enzymes appears to be important in determination of degree of effect. (auth)

29709 (UCRL-18793, pp 113-17) DETERMINATION OF TESTOSTERONE AND EPITESTOSTERONE IN URINE SAMPLES BY GAS LIQUID CHROMATOGRAPHY. Connell, Gerald M.; Linfoot, John A. (California Univ., Berkeley. Lawrence Radiation Lab.).

Gas liquid chromatographic analysis of testosterone and its 17 alpha isomer, epitestosterone, can be accomplished by this method with relative ease. These determinations can be a useful measurement for the evaluation of pituitary and gonadal function. Results obtained from urine samples of patients who have undergone pituitary irradiation are presented. The testosterone values observed are surprisingly low when compared with normal values reported for this method (male: 61.3 μg/24 hr testosterone and 45.8 μg/24 hr epitestosterone). The relatively high values for epitestosterone were unexpected, and may reflect an alteration in steroid metabolism. The examination of urine samples from diabetic patients (male and female) failed to show detectable quantities of testosterone, and may reflect a need to use more than a 200-ml urine sample in these patients. This response may be a true diminution of pituitary gonadal activity due to pituitary irradiation. (C.O.)

29710 (UCRL-19481) EFFECTS OF IONIZING RADIATIONS ON MYELIN FORMATION IN RAT BRAIN CULTURES. Mamoon, Abdel-Megid (California Univ., Berkeley. Lawrence Radiation Lab.). 31 Dec 1969. Contract W-7405-eng-48. 171p. Dep. CFSTI.

Thesis.

Organotypic cultures from newborn rat brains of different postnatal ages were maintained in an apparently healthy condition for at least two months. Explants (about 1 mm^3 in volume and 1 mm thick) from cerebella and midbrains were used. The explants were embedded in a plasma clot and incubated in roller tubes. An incubation temperature of 36°C and glucose concentration of 6.5 mg/ml of the feeding medium resulted in the highest percentage of all incubated explants becoming myelinated. Blood vessels and any preexisting myelin degenerated upon explantation. At 15 days postincubation over 90% of the incubated explants had developed abundant and apparently normal myelination. Examination of the cultures at 15 days in vitro by phase contrast and polarization microscopy, histological techniques, scanning electron microscopy, whole mount autoradiography using uridine-2-^{14}C and by electrophysiological methods showed that many nerve cells were differentiated, many axons myelinated and in general much of the structural and functional characteristics of in vivo nerve tissue were retained in vitro. These observations denote the considerable recovery that had taken place from dissection damage (involving anoxia, ischemia and physical disruption) that is reflected in low Q_{O_2} of the fresh explants (1.25 μl/mg wet weight/hr) and only about 10% survival of the large nerve cells originally present. The cultures were used as a model system for in vivo nerve tissue in investigating the damage to myelin formation by ionizing radiations. The effects of ionizing radiations on myelin formation in the cultures were studied using 145 Kvp x-rays, 36 MeV helium ions, 54 MeV helium ions and 30 MeV deuterium ions. Freshly dissected explants were exposed to radiations and the number of myelinated explants at 15 days in vitro compared to the total number irradiated was used as an index for myelination damage. The modification of such damage by radiation dose and age of animal used was investigated. The results showed, that although the radiations used differed in their LET and dose rates, they were not significantly different in their effectiveness. The mean radiation dose that resulted in only 50% of the explants (compared to the controls) becoming myelinated was 1727 ± 115 rads (mean ± 1SD). A dose above 400 rads was needed in order to produce observable effect on myelination and the damage increased with the dose. At 4000 rads all exposed explants did not develop myelin. No recovery of myelination was observed in amyelinated cultures during an observation period of one month. Explants from 8 day old animals were found to be significantly more radioresistant to myelination damage when compared to those from 1 day old animals. Many nerve cells (>20 μ) in most cultures even after exposure to 4000 rads were apparently unaffected, irrespective of age of animal used, when examined at 15 days postirradiation. The axons were similarly unaffected. In contrast, small cells (5-15 μ) which include small nerve cells and glia were markedly reduced in density by 4000 rads. It is concluded that damage to myelination in vitro is caused by direct glial cell damage. The chance for affecting more of these cells increases with the dose. Since these cells occur in greater density in explants from 8 day old animals

than in those from 1 day old animals (myelination gliosis), a higher dose will be needed to damage enough glial cells in the former explants in order to produce myelination damage. Although radiation damage to blood vessels in vivo may initiate or contribute to myelination damage, the present findings show that glial injury, in absence of blood vessels leads to myelination damage, at doses comparable to those used in vivo. (auth)

29711 (UCSF-10-P-2-93) ROLE OF REPAIR REPLICATION IN RECOVERY OF MAMMALIAN CELLS. Painter, R. B. (California Univ., San Francisco. Lab. of Radiobiology). [1969]. 11p. Dep. CFSTI.

The question of whether repair replication in mammalian cells really enhances survival after radiation damage to DNA was studied. Human diploid cells (WI-38) in mid-log phase were labeled with ^{3}H-labeled bromouracil deoxyriboside (^{3}HBrUdR) and then uv irradiated. Data conclusively showed that DNA that had incorporated ^{3}HBrUdR via repair replication subsequently replicated by the semiconservative mode. It was suggested that the significant factor for survival was probably the fraction of DNA (short-run patches of DNA randomly distributed along the length of the molecule) that was repaired to such an extent that it could perform its normal functions (semiconservative replication) and thus enhance survival. (C.O.)

29712 URINE EXCRETION OF ^{35}S BY IRRADIATED AND STARVED RATS AFTER INJECTION OF $Na_2{}^{35}SO_4$. Dancewicz, Antoni M. (Inst. of Nuclear Research, Warsaw). Nukleonika; 14: 1019-25(Oct 1969).

An investigation was made on the kinetics of ^{35}S and inorganic sulfate excretion with urine by rats given intraperitoneally labeled sodium sulfate, then irradiated with a dose of 1000 R and starved. It was found that irradiation of rats with a lethal dose causes an increase in retention of ^{35}S and of inorganic sulfate, and an increase in the excretion of other sulfur compounds of low and high molecular weight. A similar effect was observed in rats non-irradiated but starved after sham irradiation. It was concluded that changes in the kinetics of urine excretion of sulfur compounds by irradiated animals result from malnutrition developing in such animals. (auth)

29713 ELECTRON MICROSCOPIC STUDY OF DENDRITIC DEGENERATION IN THE CEREBRAL CORTEX RESULTING FROM LAMINAR LESIONS. Kruger, Lawrence; Hamori, Joseph (Univ. of California, Los Angeles). Exp. Brain Res.; 10: 1-16 (1970).

The morphological characteristics of dendrites in layers of the cerebral cortex above laminar lesions induced by ionizing particle irradiation were studied in the striate field of rat at various survival times. Within two weeks following irradiation unusual alterations, inferred to be signs of degeneration, were seen in an increasing number of dendrites. Degenerating dendrites can be characterized by a dense cytoplasmic matrix, disruption of mitochondria, presence of dense bodies, irregular outline and a marked alteration of the plasmalemma in its dimensions and staining properties. Some degenerating dendrites possess a large accumulation of dense subsynaptic material and are contacted by synapses with enlarged and altered synaptic clefts. A few dendrites contain extensive membranous whorls. Engulfment by reactive astrocyte processes is a common feature and often includes the presynaptic axonal knob, but only the degenerating dendrite was observed within glial cytoplasm. The inference that the majority of degenerating dendrites in this material are apical dendrites of pyramidal cells suggests that either shaft synapses are common for these cells, protuberances may retract during degeneration, or spines are lost due to loss of afferent terminals. (auth)

29714 COMBINED EFFECTS OF IRRADIATION, STORAGE, AND COOKING ON THE VITAMIN E AND B_1 LEVELS OF FOODS. Diehl, J. F. (Inst. of Radiation Tech. Federal Research Center for Food Preservation, Karlsruhe, Ger.). Food Irradiat.; 10: 2-7(Jul-Dec 1969).

Experiments in which vitamins E and B_1 were determined in a number of foods before and after irradiation, after storage for periods of up to 8 months, and after cooking and baking are described. The vitamin losses caused by the combined effects of radiation, storage, and heat were higher than would be expected if the effects of the individual treatments were simply additive. Experiments with sunflower oil to which vitamin E was added after irradiation show that a vitamin E destroying factor is present in the irradiated oil. Preliminary evidence suggests that the production of this factor is favored by the presence of oxygen but not completely inhibited by its absence. The stability of the factor was not or little influenced by the presence of water; in contrast to the vitamin E-destroying property of heated oils, the radiation induced factor disappeared within 20 days of storage of the irradiated oil in the presence of air. (auth)

29715 RENAL LDH, GOT, MDH, AND LAP VALUES IN THE NORMAL AND WHOLE-BODY IRRADIATED RAT. Notario, A.; Bobbio Pallavicini, E.; Scaglione, P.; Marciano, S. (Univ., Pavia, Italy). Minerva Radiol.; 14: 499-509(Nov 1969). (In Italian).

An electrophoretic study of renal soluble protein and LDH, GOT, LAP, and MDH values in the normal and whole-body irradiated rat was reported. Irradiation was generally followed by percent falls of proteins migrating to the gammaglobulin zone, and of cathodic or more slowly anodic migrating isoenzymes topographically corresponding to the protein fractions migrating with the gammaglobulins. (auth)

Immunology

Refer also to abstract 29851.

29716 EFFECT OF LEUCOGENENOL ON ANTIBODY FORMATION IN THE IRRADIATED MOUSE. Rice, F. A. H.; Lepick, Joan; Hepner, Patricia (The American Univ., Washington, D. C.). Contract N00014-67-C-0275. Radiat. Res.; 42: 164-8(Apr 1970).

Mice exposed to 400 rads of x radiation and injected with leucogenenol at 5-day intervals from 2 to 34 days after irradiation and with sheep erythrocytes 2 days after irradiation exhibited shorter latent periods and an appreciable level of hemolysin over a longer time than similarly irradiated controls that did not receive leucogenenol. Peak titer however was not enhanced. A further decrease in the latent period was observed when the mice were injected with leucogenenol at 5-day intervals, beginning 48 hr after irradiation. These results indicate that injections of leucogenenol hasten the recovery of tissues responsible for hemolysin formation after they are damaged by x radiation. The lack of an enhanced peak titer could be due to a competitive synthesis of protein by tissues other than those involved in antibody production as a result of accelerated recovery. The maintenance of a peak titer for at least 13 days in animals injected with leucogenenol might result from the continued replication of hemolysin associated with an accelerated regeneration of tissues responsible for antibody production. (auth)

29717 CANINE GROWTH HORMONE. Wilhelmi, A. E. (Emory Univ., Atlanta). Yale J. Biol. Med.; 41: 199-207 (1968).

A method of preparation of canine growth hormone that is easily adapted to small quantities of starting material is given. Because of the high yield rate, the method should be useful in preparing hormone for physiological experiments and especially for use in radioimmunoassay. (Excerpta Med.)

29718 THE PERIOD AND NATURE OF HAZARD IN CLINICAL RENAL TRANSPLANTATION. I. THE HAZARD TO PATIENT SURVIVAL. Moore, Thomas C.; Hume, David M. (Medical Coll. of Virginia, Richmond). Ann. Surg., 170: 1-11 (July 1969).

Factors affecting the survival of 113 kidney transplant patients who received drugs or irradiation to prevent rejection are reported. Azathioprine and prednisone were given for immunosuppression. Acute rejection was treated with actinomycin C and a substantial elevation in prednisone dose. Local irradiation (150 rad) to the transplant kidney was given on the first, third, fifth, and seventh days after transplantation. The initial four patients received whole-body irradiation. The average survival time of the 21 patients who died in the related living donor (RLD) group of 77 was 5.9 months, while that for the 18 patients who died in the cadaver donor (CD) group of 36 was 13.8 months. In 79% of recipient deaths, function of the transplanted kidney was adequate to maintain life. Sepsis and the most lethal hazards beyond the early technical problems of renal transplantation occurred with a substantially greater frequency in the CD group. Viral, bacterial, or fungal sepsis was a major or contributing cause of 92% of the RLD and CD recipient deaths. The greater frequency of sepsis and the other major lethal hazards to patient survival in the CD group reflects the greater degree of histo-incompatibility in this group when donor and recipient were selected at random rather than by histocompatibility matching. Hepatitis was a major hazard to patient survival. It was four times as frequent and three times as lethal in CD in comparison with RLD patients. Several specific and relatively common major hazards are cited, including early post-transplant leakage of urine at the transplant site, hepatitis, transplant nephrectomy site sepsis and abscess formation, and gastrointestinal ulceration and bleeding. It is suggested that renewed efforst be undertaken to eliminate or diminish the impact of these hazards and suggestions toward this end are made. (BBB)

29719 THE PERIOD AND NATURE OF HAZARD IN CLINICAL RENAL TRANSPLANTATION. II. THE HAZARD TO TRANSPLANT KIDNEY FUNCTION. Moore, Thomas C.; Hume, David M. (Medical Coll. of Virginia, Richmond). Ann. Surg., 170: 12-24(July 1969).

The effect of drug and radiotherapy on renal function was evaluated for 119 kidney transplant recipients. Azathioprine, prednisone, and/or local renal irradiation (150 Rad) or whole-body irradiation were given as immunosuppressants. Reduction of drug dose sometimes had a serious effect on transplant function. Severe curtailment in the level of azathioprine dose was necessary because of radiation- and drug-induced bone marrow aplasia, early transplant malfunction requiring dialysis, and the leukopenia of hepatitis. The experience with whole-body radiation was limited to four cases. The severe hypoplasia that accompanied whole-body irradiation limited the early use of azathioprine. Too heavy doses of azathioprine also produced severe hypoplasia and necessitated lower drug doses. Although severe hypoplasia may temporarily improve transplant function if rejection is threatening, it sometimes led to lethal infection and bleeding. The development of hepatitis, like whole-body-irradiation and drug-induced hypoplasia, required temporary discontinuation of azathioprine. A 20-1.2 blood urea N-creatinine ratio, or better, as an index of transplant function is described as comparable to the A and B histocompatibility match level of function found in transplants at risk more than 4 yr. (BBB)

Ecology

Refer also to abstracts 29707 and 29758.

29720 (AHSB(RP)R-97) ENVIRONMENTAL MONITORING ASSOCIATED WITH DISCHARGES OF RADIOACTIVE WASTE DURING 1968 FROM UKAEA ESTABLISHMENTS. Wray, E. T. (ed.) (United Kingdom Atomic Energy Authority, Harwell (England). Authority Health and Safety Branch). Oct 1969. 22p. Dep. CFSTI (U. S. Sales Only).

The results of the monitoring programmes carried out in connection with radioactive waste discharges from the principal establishments of the UKAEA in 1968 are summarized. The information given includes the essential features of the authorizations for discharges in force at each establishment together with details of the actual discharges which were made and the results of environmental monitoring. The latter results are summarized and are compared with derived working limits to facilitate an appreciation of the standards of safety achieved. (auth)

29721 (BMI-171-29) BIOENVIRONMENTAL AND RADIOLOGICAL-SAFETY FEASIBILITY STUDIES, ATLANTIC-PACIFIC INTEROCEANIC CANAL: RADIONUCLIDE AND STABLE-ELEMENT ANALYSES OF ENVIRONMENTAL SAMPLES FROM ROUTES 17 AND 25. Ewing, R. A.; Howes, J. E.; Price, R. B. (Battelle Memorial Inst., Columbus, Ohio). 2 Dec 1969. Contract AT(26-1)-171. 52p. Dep. CFSTI.

In connection with a projected interoceanic canal produced by nuclear excavation, more than 300 samples of raw and prepared food stuffs were collected along route 17 (Panama) and route 25 (Colombia). This material was then studied for its elementary composition. The need for some across-the-board analyses was partially satisfied by spark-source mass spectroscopy that provided semiquantitative and upper-limit values for many elements. Atomic-absorption analysis and neutron-activation analysis were used to analyze samples for specific critical elements. Radiochemical analyses were performed for the determination of radionuclides in the Isthmian environment with emphasis on ^{137}Cs, ^{90}Sr, and ^{239}Pu. Results were compiled in five tables. (H.B.G.)

29722 (EUR-4383) RADIOACTIVE CONTAMINATION OF FOODSTUFFS IN THE COUNTRIES OF THE COMMUNITY IN 1967. (European Atomic Energy Community). 1969. 68p. (In several languages). Dep. CFSTI (U. S. Sales Only). EUR.

This report contains measurement data on the radioactive contamination of foodstuffs in the Community countries in 1967. The data relate to the radionuclides ^{90}Sr and ^{137}Cs. Tables and graphs illustrate the pattern followed in the course of the year. The average milk contamination for the Community is compared with that of the United States, Canada, and the United Kingdom. An estimate is given of the strontium-90 intake. For 1967 this intake averages 4,468 pCi of strontium-90, which corresponds to 17.2 pCi/gCa in the diet. Results obtained during 1967 with the comparative study of the radioactive contamination of the total diet of adolescents in the Community are also given. (auth)

29723 (NP-18094) BIOLOGICAL ASPECTS OF FALLOUT IN AUSTRALIA FROM FRENCH NUCLEAR WEAPONS EXPLOSIONS IN THE PACIFIC, JULY-SEPTEMBER 1968. (National Radiation Advisory Committee, Canberra (Australia)). Mar 1969. 13p. Dep. CFSTI (U. S. Sales Only).

The results of a survey made of fresh fission products in fallout from French nuclear weapons tests in the South Pacific in July to September 1968 are summarized. Full text of the survey report is attached as an appendix. The survey report was also published in Aust. J. Sci., 31: 383-8(May 1969). An abstract prepared from this article appeared in NSA 23: 38100. (Australia)

29724 (NP-18140) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND AND MEASUREMENTS ON SAMPLES FROM FIJI AND ROROTONGA. Quarterly Report, April-June 1969. (National Radiation Lab., Christchurch (New Zealand)). 11p. (NRL-F-35). Dep. CFSTI (U. S. Sales Only).

Results of routine monitoring of fallout in air, rain and milk samples during the second quarter 1969 are tabulated in this Report. These results are summarized on a quarterly basis and are presented graphically, together with results from previous quarterly reports during 1968 and 1969. The amount of ^{90}Sr in rain decreased slightly, ^{89}Sr in rain fell steadily, ^{90}Sr in milk increased slightly, and ^{137}Cs in milk decreased slightly. (C.O.)

29725 (UCD-472-116, pp 127-8) FALLOUT ^{137}Cs ACCUMULATION IN TWO SUBPOPULATIONS OF COLUMBIAN BLACK-TAILED DEER (ODOCOILEUS HEMIONUS COLUMBIANUS). Book, S. A. (California Univ., Davis. Radiobiology Lab.).

The variation in fallout ^{137}Cs concentrations in rumen contents and muscle of deer inhabiting oak woodland and chaparral cover types was investigated in relation to availability of preferred forage species and foliar contamination by ^{137}Cs. (auth)

29726 ^{210}Pb IN AIR AND TOTAL DIETS IN THE UNITED STATES DURING 1966. Magno, P. J.; Groulx, P. R.; Apidianakis, J. C. (Consumer Protection and Environmental Health Service, Winchester, Mass.). Health Phys.; 18: 383-8(Apr 1970).

Data are presented on the concentrations of lead-210 in air and diet samples collected from various geographical locations in the United States during 1966. The average lead-210 concentration in air particulates for 1966 differed significantly between locations and ranged from 4.8 to 26.1 fCi/m^3. The concentration in total diet was not significantly different between locations and averaged 0.80 pCi/kg. From these data it was estimated that an average of 0.15 to 0.21 pCi/day of lead-210 reaches the blood stream of inhabitants of the United States from these sources of exposure and that about 70 to 90% of this amount comes from ingestion. (auth) (UK)

29727 BIOLOGICAL STUDIES OF AMBIENT RADIOACTIVITY. II. THE ECOLOGY OF RADIONUCLIDES. Rossi, Luciana Cigna; Cigna, Arrigo A. (CNEN, Casaccia, Italy). G. Fis. Sanit. Prot. Radiaz.; 12: 261-71(Oct-Dec 1968). (In Italian). (RT/PROT-(69)30).

The problems concerning the disposal of the radioactive wastes produced by nuclear plants are discussed with reference to the receiving environment. The permissible levels of discharge both for gaseous and for liquid wastes are also considered and some derived working levels are proposed. A scheme of an environmental ecological survey is reported. (auth)

29728 BIOLOGICAL ASPECTS OF THERMAL POLLUTION. Proceedings of the National Symposium on Thermal Pollution, Portland, Oregon, June 3-5, 1968. Krenkel, Peter A.; Parker, Frank L. (eds.). Nashville; Vanderbilt University Press (1969). 424p. $7.95. (CONF-680638).

Twelve papers given during the proceedings of the national symposium on the biological aspects of thermal pollution held at Portland, Ore., June 3 to 5, 1968 are presented. Separate abstracts were prepared for 3. One appeared in NSA previously as 23: 12039. The remaining 8 papers contain material not within the scope of NSA. (L.C.L.)

For abstracts of individual chapters see: 29435, 29729, and 29730.

29729 KEYNOTE ADDRESS. Black, David S. (Under Secretary of the Interior, Washington, D. C.). pp 3-9 of Biological Aspects of Thermal Pollution. /Krenkel, Peter A. (ed.). Nashville; Vanderbilt University Press (1969).

From National Symposium on Biological Aspects of Thermal Pollution, Portland, Oreg. See CONF-680638.

The importance of environmental and esthetic consequences of building nuclear power plants along lakes, river, and streams is emphasized and the effects of thermal pollution on the ecological balance are discussed. Harmful effects of increased temperature on hatching of fish, the food supply of fish, and sensitivity to toxic substances are pointed out. Possible methods of improving man-

agement of waste heat to make it less harmful to the environment are discussed. Problems associated with construction of cooling towers, cooling ponds, and spray ponds for the disposal of excess heat are examined. Possible constructive uses of heat are suggested, such as warm water cultivation of oysters and the use of heated water for irrigation. (H.L.W.)

29730 ASPECTS OF THE POTENTIAL EFFECT OF THERMAL ALTERATION ON MARINE AND ESTUARINE BENTHOS. Hedgpeth, Joel W.; Gonor, Jefferson J. (Oregon State Univ., Newport). pp 80-118 of Biological Aspects of Thermal Pollution. /Krenkel, Peter A. (ed.). Nashville; Vanderbilt University Press (1969).

From National Symposium on Biological Aspects of Thermal Pollution, Portland, Oreg. See CONF-680638.

A review is presented of the effects of natural sea temperature changes on marine organisms. The interaction of temperature changes with other factors such as oxygen and salinity is described. Studies on the association of cooling or warming trends in the sea with fluctuations in populations of marine organisms are reviewed. Numerous examples are given of the relation between seasons and annual reproductive cycles with emphasis on temperature as the most important factor. A discussion is presented of the prospects of marine aquiculture of benthic organisms in heated waters. Studies on the use of heated effluents to increase production of phytoplankton and fish are reviewed. Studies on the clam, Venus mercenaria, showed that clams reared in water warmed by power stations had extended growth periods and an increase in growth rate. It was concluded that the use of heated effluent water to increase production in natural and uncontrolled populations of economically important invertebrates is limited, but that the potential for such use in closed or restricted systems deserves further inquiry. (H.L.W.)

Genetics and Cytogenetics

Refer also to abstracts 29848, 29872, 29876, 29894, and 29896.

29731 (UCD-472-116, pp 121-2) CYTOGENETIC EFFECT OF IN VITRO IRRADIATION OF MARMOSA MITIS LYMPHOCYTES. Wolf, H. G.; Foin, Angela; McCullough, J. (California Univ., Davis. Radiobiology Lab.).

Peripheral leukocytes from Marmosa mitis were x irradiated in vitro at 5, 10, 20, 40, and 80 R. Cultures irradiated at the two highest levels sustained more damage than did control cultures. Irradiation at levels of 20 R or below did not increase cytogenetic damage over control levels. The dose-effect relationship appears to be linear. (auth)

29732 (UCD-472-116, pp 123-4) KARYOMETRICS OF THE CHROMOSOMES OF MARMOSA MITIS. Bruner, H. D. (California Univ., Davis. Radiobiology Lab.).

Optical scanning and computerization are being utilized for the measurement of chromosomes of Marmosa mitis, to define baseline values as an aid in assessing radiation-induced cytogenetic damage. (auth)

29733 BEHAVIOR OF COLIPHAGE LAMBDA IN HYBRIDS BETWEEN ESCHERICHIA COLI AND SALMONELLA. Baron, L. S.; Penido, Elisa; Ryman, I. R.; Falkow, Stanley (Walter Reed Army Inst. of Research, Washington, D. C. Georgetown Univ., Washington, D. C.). J. Bacteriol.; 102: 221-33(Apr 1970).

Salmonella typhosa hybrids able to adsorb lambda were obtained by mating S. typhosa recipients with Escherichia coli K-12 donors. After adsorption of wild-type λ to these S. typhosa hybrids, no plaques or infective centers could be detected. E. coli K-12 gal^+ genes carried by the defective phage λdg were transduced to S. typhosa hybrids with HFT lysates derived from E. coli heterogenotes. The lysogenic state that resulted in the S. typhosa hybrids after gal^+ transduction differed from that of E. coli. Ability to produce λ, initially present, was permanently segregated by transductants of the S. typhosa hybrid. S. typhosa lysogens did not lyse upon treatment for phage induction with mitomycin C, ultraviolet light, or heat in the case of thermoinducible λ. A further difference in the behavior of λ in Salmonella hybrids was the absence of zygotic induction of the prophage when transferred from E. coli K-12 donors to S. typhosa. A new λ mutant class, capable of forming plaques on S. typhosa hybrids refractory to wild-type λ, was isolated at low frequency by plating λ on S. typhosa hybrid WR4254. Such mutants were designated as λsx, and a mutant allele of λsx was located between the P and Q genes of the λ chromosome. Plaques were formed also on the S. typhosa hybrid host with a series of λ^{i21} hybrid phages which contain the N gene of phage 21. The significance of these results in terms of Salmonella species as hosts for λ is discussed. (auth)

29734 THE EFFECT OF THORON INHALATION ON THE MITOTIC ACTIVITY IN THE KIDNEYS. Tadzhikov, M. M.; Sharipov, F. Kh. (Tadzhik Medical Inst., USSR). Byull. Eksp. Biol. Med.; 69: No. 1, 83-5(Jan 1970). (In Russian).

The effect produced by inhalation of an aero-thoron mixture on the mitotic activity in the kidneys was studied in albino rats weighing 200 g each. Separate content of ThB and ThC was determined by measuring the renal γ-activity. After a 2-hour long inhalation of the air with thoron concentration therein reaching $2.5 \cdot 10^{-5}$ curie the absorbed radiation dose given to the rat's kidneys through the Th (C + C') α-radiation comprised 26.6 ber. Such a single dose causes reversible stimulation of mitotic activity in the epithelium of convoluted tubules of the cortical and collecting tubules of the medullary substance. (auth)

29735 ISOLATION AND PARTIAL CHARACTERIZATION OF ESCHERICHIA COLI MUTANTS WITH ALTERED GLYCYL TRANSFER RIBONUCLEIC ACID SYNTHETASES. Folk, William R.; Berg, Paul (Stanford Univ., Calif.). J. Bacteriol.; 102: 193-203 (Apr 1970).

Isolates with mutations in glyS, the structural gene for glycyltransfer ribonucleic acid (tRNA) synthetase (GRS) in Escherichia coli, are frequently found among glycine auxotrophs. Extracts of glyS mutants have altered GRS activities. The mutants grow with normal growth rates in minimal media when high levels of glycine are provided. No other metabolite of a variety tested is capable of restoring normal growth. The glyS mutants fail to make ribonucleic acid (RNA) when depleted of exogenous glycine in strains which are RC^{str} but do so when the cells are RC^{rel}. In contrast, biosynthetic mutants which are unable to synthesize glycine (glyA mutants) do not make RNA when deprived of glycine even if they are RC^{rel}; in this case, RNA is synthesized upon glycine deprivation only when the nucleic acid precursors made from glycine are provided in the medium. The level of serine transhydroxymethylase is unaltered in extracts of any of the glyS mutants, even though the level of charged $tRNA^{Gly}$ is at least 20-fold lower than that found in a prototrophic parent; this indicates that, if there is control over the synthesis of serine transhydroxymethylase, it is not modified by reduced levels of charging of the major species of $tRNA^{Gly}$. (auth)

29736 EFFECT OF OXYGEN TENSION ON CHROMOSOME ABERRATIONS INDUCED BY IONIZING RADIATIONS IN EHRLICH ASCITIC TUMOR. Piccotti, F.; Ballaira, L. (Univ., Turin). Minerva Radiol.; 14: 510-16(Nov 1969). (In Italian).

The effect of differences in oxygen tension during irradiation of Ehrlich ascitic tumor cells on the chromosome aberrations produced by such irradiation is reported. It is shown that increased tension leads to an increased number of aberrations, particularly breaks of the chromosomal type, and a corresponding decrease in translocations. Some interpretations of the results are discussed and emphasis is laid on the importance of the repair of chromosome damage in the mechanism of the oxygen effect. (auth)

29737 GENETIC RECOMBINATION BETWEEN CLOSELY LINKED MARKERS OF BACTERIOPHAGE T4. I. A DUAL MECHANISM FOR RECOMBINANT FORMATION. Honda, Masaaki; Uchida, Hisao (Tokyo Univ.). Genetics; 63: 743-58(Dec 1969).

Based on a comparative study of uv cross-reactivation behavior of T4 phage, a dual mechanism for recombinant formation in T4 genetic crosses is proposed. The breakage and union of two parental DNA molecules is responsible only for the production of recombinants by single exchange, whereas recombinants requiring close multiple exchanges are produced by a different route through a structure parental with respect to the adjacent regions outside a short material overlap. The model is useful to resolve some of the previously experienced inconsistencies in the current theory of genetic recombination in bacteriophage. (auth)

Health Physics and Safety

Refer also to abstracts 29425, 29495, and 29964.

Radioactive Contamination and Decontamination

Refer also to abstracts 29700, 29722–29724, and 29726.

29738 (NP-18208) THE PROBLEM OF LARGE-AREA PLUTONIUM CONTAMINATION. Bureau of Radiological Health Seminar Paper No. 002. Langham, Wright H. (Los Alamos Scientific Lab., N. Mex.). [1968]. 15p. CFSTI.

Physiological and toxicological properties of plutonium are reviewed in relation to development of neoplasms in animals and uptake from soils to plants. A brief review is presented of incidents resulting in large-area plutonium contamination. The first occurred in 1945 in New Mexico with the first test of a plutonium

fission weapon. Another example involved worldwide contamination from plutonium produced by nuclear weapons testing and reentry burnup of one ^{239}Pu thermoelectric generator in connection with a space mission failure. In 1966 an aerial refueling explosion occurred in Spain; 600 acres of crop areas were contaminated by the detonation of a plutonium-bearing nuclear weapon. In 1968 a B-52 bomber with four plutonium-bearing nuclear weapons crashed on the ice near Thule, Greenland. It was found that a large fraction of the plutonium was trapped in the blackened crust on top of the snow pack. The problem of plutonium contamination from noncritical nuclear weapons detonations is discussed with regard to the risks of inhaling plutonium during cloud passage and deposition and permanent occupancy of a contaminated area. Maximum permissible initial surface concentration levels for lifetime occupancy were calculated and results are tabulated. Risk assessment based on the number and size of particles in the lung is discussed and a table is presented to show activity of $^{238}PuO_2$ and $^{239}PuO_2$ particles as a function of particle diameter. (H.L.W.)

29739 (RD/B/M-1354) CRITICAL ANALYSIS OF ICRP DERIVATION OF MAXIMUM PERMISSIBLE CONCENTRATION OF TRITIUM. Whitton, J. T. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov 1969. 19p. Dep. CFSTI (U. S. Sales Only).

The derivation of the maximum permissible concentration (MPC) of tritiated water or water vapor is critically reviewed. The ICRP calculations (ICRP Publication 2, 1959) for tritium are presented in detail from first principles to the final results. It is shown that ICRP values for the MPC are extremely well founded and there is no reason for supposing the hazard from exposure to tritium to be more serious than at present thought. It is shown that the greatest possible revisions in the physical and biological basis of tritium dosimetry would not involve changes of more than a factor of two in the resultant MPC values. (auth)

29740 (UCD-472-116, pp 129) EVALUATION OF ION EXCHANGE DECONTAMINATION OF ^{90}Sr FROM ORGANIC WASTE. Goldman, Marvin; Shiomoto, Ken (California Univ., Davis. Radiobiology Lab.).

Eight yrs' experience in cation exchange decontamination of processed excreta from dogs fed ^{90}Sr is reviewed. Over 0.5 Ci of ^{90}Sr was processed in 1.5 million gallons, with an average decontamination factor of 10^3. (auth)

29741 CONTRIBUTION OF ACTIVITY RELEASED FROM PROTECTIVE CLOTHING TO AIR CONTAMINATION MEASURED BY PERSONAL AIR SAMPLERS. Butterworth, R.; Donoghue, J. K. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Health Phys.; 18: 319-23(Apr 1970).

Air contamination measured with personal air samplers is usually greater than that indicated by fixed samplers in the working area. The discrepancy may be partly explained if activity released from contaminated clothing is collected by the personal air sampler and measurements have shown this to be the case. Cotton coveralls contaminated in a uranium processing area gave air levels in excess of the uranium-in-air MPC when worn in a clean laboratory. The effect with terylene/cotton coveralls was somewhat less than with pure cotton. (auth) (UK)

29742 CONTENT OF ^{137}Cs AND POTASSIUM IN THE DIET OF SOME POPULATION GROUPS AND IN SOME FOODSTUFFS IN POLAND DURING 1965–1966. Pietrzak-Flis, Zofia (Central Lab. for Radiological Protection, Warsaw). Nukleonika; 14: 1027-36(Oct 1969).

Contents of ^{137}Cs and K were determined for the period of 1965 to 1966 in diets of 4 to 6 year-old children from Warsaw and 16 to 18 teenagers from Sochaczew, and also in milk, meat, flour, potatoes and vegetables collected in Warsaw and at Sochaczew. The daily intake of ^{137}Cs in diets was similar in both age groups, and in 1966 it was about 20% lower than in 1965. On the basis of the determined daily intakes the body burdens were calculated for the two age groups. In 1965 in central Poland the major contribution to the ^{137}Cs content in diet was from meat (38.6%), lower amounts being absorbed from milk (34.6%), cereals (16.8%), and potatoes (8.9%). Content of ^{137}Cs in milk and flour remained practically constant in 1965 and 1966, whereas that in meat and potatoes was in 1968 1.8 and 1.4 times lower than in 1965, respectively. (auth)

Dosimetry and Monitoring

Refer also to abstracts 29783, 29836, and 30671.

29743 (DMRE-69-3, pp 5-59) CHARACTERISTICS OF RADIATION MONITORING INSTRUMENTATION AND METHODS. Brodsky, Allen (Pittsburgh Univ., Pa. Graduate School of Public Health).

Some of the basic principles of radiation measurement for protection purposes are discussed. Basic units of radiation measurement, the Roentgen, integral absorbed dose, Roentgen equivalent man, gram-rem, and Curie, are defined. The principles of dose measurement are outlined and personnel dosimetry is treated in detail, emphasizing the film badge. Portable radiation survey instruments are discussed, and the problem of assessment of internally deposited radionuclides is presented. The accuracy and precision of the methods for radiation measurement are discussed in relation to the precision that may be warranted, considering the variability of biological response of even a single strain of organism exposed to a single type of radiation. It was concluded that no amount of precision in radiation dosimetry will serve litigation purposes if these purposes include a requirement for the absolute verification of a causal relation between exposure and long-term disease, because this relation is, at best, probabilistic. Graphs, illustrations, and tables are provided. (85 references) (C.O.)

29744 (DMRE-69-3, pp 82-90) RADIATION QUANTITIES AND UNITS AND THE SIGNIFICANCE OF RECORDED MEASUREMENTS. Willhoit, Donald G. (North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering).

The use of the term, dose, and the different meanings it may have are discussed. The difference between exposure and absorbed dose is illustrated and absorption of dose as a function of depth in tissue is discussed. Dose equivalent (or Rem) is defined and it is pointed out that this alone is not sufficient since the critical organ must also be specified. It is stated that much of the controversy regarding the significance of personnel monitoring measurements and records has been due to a misunderstanding of what is being measured and recorded and the philosophy or intent of the measurement. If the purpose of the radiation exposure record is to provide sufficient dosimetric information for evaluation of the biologically significant dose then a single number is inadequate in view of the current state of the art. Even if the dose distribution is known in detail, there is no simple way to reduce the dose distribution to a single number. Five principal factors of irradiation are listed as necessary information: target volume, type and energy of the radiation, method of irradiation, pattern of absorbed dose, and time distribution. (C.O.)

29745 (DMRE-69-3, pp 138-46) PATIENT AND PERSONNEL DOSE DURING RADIOTHERAPY. Almond, Peter R. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.).

The patient dose will be determined by machine calibration and machine parameters that should be determined at installation and routinely checked; by patient parameters and the clinical aim; and by correct calculation of treatment time and administration of the treatment. All the pertinent information should be included in the data book and on the patient chart so that the total dose and the daily given doses can be confirmed. Personnel dose will be determined by adequate shielding and protection of the machine and safe procedures that result in a minimum exposure to the personnel. Records should be kept of a protection survey and the operation of safety devices on the machine, records must also be kept of the exposures measured by film badge monitors. It must, of course, be realized that accidents and errors will occur. The procedures described were developed over the years in order to reduce these to a minimum and when they do occur, to be able to detect them quickly enough so that corrective action may be taken. (auth)

29746 (DMRE-69-3, pp 153-71) PATIENT AND PERSONNEL DOSE DURING RADIOISOTOPE PROCEDURES. Kereiakes, James; Horwitz, Harry; Saenger, Eugene L. (Cincinnati General Hospital, Ohio. Radioisotope Lab.); Wellman, Henry; Sodd, Vince (Bureau of Radiological Health, Cincinnati, Ohio. Nuclear Medicine Lab.).

Personnel and patient doses as a result of radioisotope procedures are reviewed. The great differences in dose to the different parts of the body of personnel are noted. The increased exposure of personnel is thought to be because of the increased number of clinical procedures as well as the increasing number of high-activity generators in use. Reeducation of personnel concerning radiation safety procedures is suggested. Sample radioisotope laboratory patient forms are given and dose calculations for internal dosimetry are discussed. Radiation doses from radiopharmaceuticals in adults and children are given in tables for ^{198}Au, ^{199}Au, ^{47}Ca, ^{51}Cr, ^{59}Fe, ^{197}Hg, ^{131}I, ^{85}Sr, and ^{99}Tc. It is stated that the overall dose per procedure in nuclear medicine is of the same order of magnitude as that in diagnostic radiology. (C.O.)

29747 (UCD-472-116, pp 100-1) BETA-EMITTING ASSAY OF RADIOSTRONTIUM ISOTOPE MIXTURES UTILIZING CERENKOV RADIATION. Goldman, M.; Beckman, Edwina (California Univ., Davis. Radiobiology Lab.).

Two-channel differential counting of beta-emitting isotopes in

aqueous solution provides a sensitive method for assay of beta radiation. Detection efficiencies of over 20% for ^{89}Sr and $^{90}Sr-^{90}Y$ are reported. (auth)

29748 (UCRL-18793, pp 128-34) ACTINIDE ELEMENT STUDIES WITH A Si(Li) "WOUND COUNTER". Parker, Howard G.; Wright, Stephen R.; Low-Beer, Anne deG. (California Univ., Berkeley. Lawrence Radiation Lab.).

Preparations have been made for the use of a Si(Li) crystal wound counter to identify and quantitate x-ray-emitting actinide elements in human wounds, and to measure their depth in tissue. A small library of actinide sources and their spectra has been accumulated for the purpose. The paper gives preliminary results on some properties of the counter, computer processing of the data, the actinide x- and gamma-ray spectra obtained, the depth measurement, and some absorber studies related to the depth measurement. (auth)

29749 MONITORING SYSTEMS AND EVALUATION OF THE DOSE OF RADIOACTIVE SUBSTANCES INTRODUCED INTO THE PULMONARY CIRCULATION. Cellerino, A.; Catolla Cavalcanti, R.; Gaetini, A.; Banaudi, C. (Univ., Turin). Minerva Fisiconucl., 12: 35-8(Jan.-Mar. 1968). (In Italian).

In the field of clinical diagnostic and radiation protection ventilocirculatoric data for the internal lung space are of great interest. By means of radioisotopes it has become possible to examine the function of the lung and its parts in vivo. For the observation from the outside penetrating γ rays are used, emitted from injected organic compounds with ^{51}Cr, ^{131}I, and ^{99}Tc, or inert radioactive gases such as ^{133}Xe. External counting is done with scintillation counters, attached with suitable collimators directly to the thorax, or by more or less rapidly moving scanning counters. In case of inhalation one must account for nasal and bronchial retention and natural exhalation. For internal dosimetry, particularly the calibration of instruments and sources, phantoms have been constructed that simulate anatomy and radiation absorption of the living tissue in great detail and in great possible accuracy. Best results were obtained with sponge-like polyurethane which has the same absorption characteristics as parenchyme tissue. The soaked parts are simulated by a liquid suspension of granules consisting of a mixture of polythene-nylon-charcoal with CaF_2. The isoabsorption curves of these phantoms with respect to the human body are given. For non-penetrating β-emitters such as ^{85}Kr one monitors the exhalation of a radioactive gas that has been injected into the bloodstream. Rapidity of circulation and exhalation are measured either with several Geiger counters, suitably arranged along the stream of exhaled air, or one single solid-state counter (Si drifted with Li, 200 mm^2 surface, 200 thickness). Presently much use is made of wash-out curves of radiokrypton with He. The combination of the external with the internal radiologic method is most revealing inasmuch as it reveals the anatomic and functional deficiencies of various lung compartments. As an example of their application the findings on a man are discussed whose left lobe had been removed 7 years before examination. The remaining lobe shows great disorganization in structure and function inasmuch as two compartments show hypo- and one compartment hyper-ventilation. (F.J.W.)

29750 EFFECT OF BATHS AND INHALATION OF RADON WATER OF SWIERADOW ON THE RADIOACTIVITY OF HUMAN BLOOD AND URINE. Glowiak, Bohdan; Halawa, Bogumil; Palczynski, Ryszard; Rog-Malinowski, Miron; Ziolkowski, Janusz. Pol. Tyg. Lek.; 24: 1955-7(Dec 1969). (In Polish).

The radioactivity of blood and urine in patients treated with radon inhalations and baths at Świeradów was studied. The overall duration of baths was 4 times shorter than duration of inhalation. Almost a twofold increase of blood radioactivity and a 1.4 increase of urine radioactivity was found in patients treated with radon inhalations. Cases subjected to radon baths exhibited a 2.6 increase of blood radioactivity and 1.3 increase of urine radioactivity. The increase of radioactivity of blood and urine after radon inhalation and bath was not dependent on the age of patients or on their main disease. (auth)

29751 STRAALDOSER FRAAN RADIOAKTIVA AEMNEN I MEDICINSKT BRUK. (Radiation Doses from Radioactive Materials Used in Medicine). Lindell, Bo. Stockholm; Statens Stralskyddsinstitutet (1969). 101p.

Doses per μCi are reported according to ICRP doses from radioactive compounds in medical use and statistical information on administration of radioactive compounds to patients for diagnostic purposes. (auth)

29752 COMPUTER PROGRAM FOR 3-D PLANNING IN EXTERNAL BEAM RADIATION THERAPY, EXTD0S. van de Geijn, J. (Joannes de Deo Hospital, The Hague). Comput. Programs Biomed.; 1: No. 1, 47-57(Jan 1970).

A computer program is developed for three dimensional calculation of dose distribution for radiotherapy patients. The program applies to rectangular beams of high-energy x-rays and ^{60}Co γ radiation interacting with unit density tissue. The distribution of absorbed dose is obtained by accumulating the weighted contributions from all the beam positions at all points of a three dimensional grid. After suitable normalization, a quadratic interpolation method is used to compute and display isodose surfaces by means of sets of isodose lines in mutually parallel planes. For ^{60}Co γ radiation machines, basic treatment times are calculated. (H.B.G.)

29753 PROSPECTS OF PERSONAL DOSIMETRY OF FAST NEUTRONS. Busuoli, G. (Laboratorio di Fisica Sanitaria, Bologna). Minerva Fisiconucl., 12: 55-8(Apr.-June 1968). (In Italian).

Various methods are used for personal dosimetry of fast neutrons. They all have numerous shortcomings. The most common method uses films with nuclear emulsions. Here development and reading are tedious and time-consuming; the accuracy is affected by sensitivity to γ-rays and high resolution threshold. On the other hand Si-diodes, while insensitive to γ-rays, respond only to high doses and, besides, their accuracy is highly energy-dependent and they fade within an hour. Chemical dosimeters are not practical for purposes of personal dosimetry. Thermoluminescence dosimeters are insensitive to fast neutrons, and generally not accurate. The only dosimeter that is free from all above shortcomings consists of a plastic film into which finely divided fissionable matter is embedded. When a heavily charged particle passes through such a foil it creates along its track a damage zone of 30 Å diameter. The solubility and chemical reactivity of the damaged matter makes it more readily affected by chemical agents such as a 30% KOH solution. Therefore the tracks can be easily distinguished from the surrounding zone with an ordinary optical microscope; the reading and counting can even be carried out automatically with microscope and photomultiplier. Fissionable materials that serve are ^{235}U, ^{238}U, ^{232}Th, and ^{237}Np. The advantages of the fission dosimeter are: wide range of velocity discernment; no fading; insensitivity to any other type of radiation; no development problems; ease in track detection and counting; relatively low price. The only difficulty consists in the possibility of contamination through breakage during manufacture or application. (F.J.W.)

Radiation Protection

Refer also to abstracts 29813 and 29886.

29754 RADIATION PROTECTION OF THE REPRODUCTIVE ORGANS DURING RADIOGRAPHY OF THE HIP JOINTS. McGlone, Willard E. Radiol. Technol.; 41: 277-9(Mar 1970).

A lead shield in a Plexiglas holder is described that was designed to protect the gonads of both female and male patients during radiography of the hip joint. The shield should be made in three different sizes to match the film sizes used for various size patients. (C.H.)

29755 PROTECTION FROM SOURCES OF IONIZING RADIATION IN A RADIOLOGICAL SERVICE. Muscettola, G.; Del Vecchio, E.; Fava, G. (Univ., Milan. Univ., Naples). Radiol. Med.; 55: 1041-60(Nov 1969). (In Italian).

The mechanism leading to the formation of a field of scattered radiation during the normal operation of a radiological service is described and the physical and technical means employed to protect physicians and operators from the danger of over-exposure are discussed. The subject is dealt with on a general plane by means of reference to a radiological service equipped with an x-ray therapy room and two x-ray diagnostic rooms. The mathematical formulae used in calculating the thickness of the anti-x-ray barriers required by the Ministerial Decree of 6/6/1968 for different groups of persons employed in or about the service area are explained. It is pointed out that such barriers, although an effective means of protection against the risk of over-exposure, are not sufficient unless doctors and technicians are scrupulous in the observance of the relevant rules concerning radioprotection. It is only in this way that the risk to which the personnel of a radiological service is exposed will be kept to a minimum, i.e., to the level of normal risk presented by every other professional activity. (auth)

29756 MORTALITY AND RADIATION EXPOSURE OF MASSACHUSETTS DENTISTS. Warren, Shields; Lombard, Olive M. (New England Deaconess Hospital, Boston). Contract AT(30-1)-3777. J. Amer. Dent. Ass.; 80: 329-30(Feb 1970). (NYO-3777-32).

It was shown in a study of Massachusetts dentists that, in a six-year period, a significant increase in film speed and reduction in milliampere "on" time were achieved in the use of dental x-ray apparatus. Among dental society members was no excess mortality ascribable to the use of radiation and it is believed that x-ray procedures now carried out are safe. (auth)

29757 OCCUPATIONAL SAFETY DURING X-RAY TESTING OF MATERIALS. Partolin, O. F. Mashinostroitel; No. 7, 37-40(Jul 1969). (In Russian).

The basic safety criteria applicable to the x ray testing of materials are examined. These criteria are based on the results of investigations into the spatial distribution of scattered x radiation during the radiographic testing of workpieces under various conditions and using various x-ray apparatus employed in materials testing laboratories, in factories and plants, and in factory stockyards. The main technical characteristics of six Soviet x-ray apparatuses for materials testing are described and the shielding thickness required for protection against direct and scattered radiation depending on the distance from the x-ray tube is given. Results of measurements to determine the danger zone are reproduced. Necessary measures for protection against radiation are discussed using a practical example. (Occup. Safety and Health Abstr.)

Safety Procedures

Refer also to abstracts 29921, 30003, and 30610.

29758 (BNL-14628) PUBLIC AND RADIATION FROM NUCLEAR POWER PLANTS. Bond, V. P. (Brookhaven National Lab., Upton, N. Y.). 21 Apr 1970. 9p. Dep. CFSTI.

The contribution of radiations emitted to the atmosphere during the operation of nuclear power plants to the 170 mrem/year maximum permissible dose (MPD) for the general population established by the Federal Radiation Council is discussed. It is pointed out that at present only an extremely small segment of the United States population is exposed to measurable amounts of radiation from reactors, and the radiation dose received by these persons in only a very minute fraction of the 170 mrem/yr MPD. Calculations indicate that the current average radiation dose would be of the order of 10^{-2} mrem/yr if all reactors were operating at the maximum allowable limit. Actual operation results in an average exposure of only one percent of permissible limits. The operation of 40 times the present number of nuclear power plants would result in a radiation dose to individuals living near the operating reactor below 5 mrem/yr. The risk from this dose can be compared with radiation risks from diagnostic radiography (100 mrem/yr); the risks from living in some concrete structures (100 mrem/yr); or the radiation dose during a trans-USA jet flight (1 mrem). (C.H.)

29759 RADIATION PROTECTION IN THE OPERATING ROOM. Betz, B.; Goettel, K.; Wachsmann, F. (Gesellschaft fuer Strahlenforschung mbH, Munich). Chirurg; 40: 398-402 (Sep 1969). (In German).

Routine protective measures against radiation damage to both patients and personnel are discussed with respect to diagnostic and therapeutic radiation procedures during surgery. Due to the fact that radiation sources are handled by inexperienced people, small radiation burdens can be 10 to 100 times larger than necessary because small errors do not add up but multiply each other. (H.B.G.)

Legal Aspects

Refer also to abstracts 29720, 29775, and 31029–31031.

29760 (DMRE-69-3) MEDICAL RADIATION INFORMATION FOR LITIGATION. Proceedings of a Conference held on November 21-22, 1968 at Baylor University College of Medicine, Houston, Texas. Bushong, Stewart C.; Cox, John L.; Collins, Vincent P.; Neibel, John B.; Murphy, George B. (eds.) (Bureau of Radiological Health, Rockville, Md.). Jul 1969. Contract CPE-R-69-01. 392p. (CONF-681131). GPO $3.50.

Separate abstracts were prepared for each of the 21 papers. The list of participants, opening and closing remarks, and records of discussions following paper presentations are also given. The purpose of the conference was to explore the feasibility of collecting and maintaining records of medical radiation exposure for purposes of potential litigation. (C.O.)

For abstracts of individual papers see: 29743–29746, 29761–29773, 29775, 29783, 29820, and 29883.

29761 (DMRE-69-3, pp 130-6) DIAGNOSTIC X-RAY RECORDS-KEEPING. Lusted, Lee B. (Loyola Univ., Hines, Ill. Dept. of Radiology).

Diagnostic x-ray records keeping is discussed in a decision-making context. Usefulness is emphasized in relation to the values and costs of the system. The types of records of a diagnostic x-ray department should include the following: film badge exposure record; health records of employees; exposed radiographs of a patient; radiographic consultation reports; calibration of radiographic and fluoroscopic equipment; radiation protection survey of a department; and continuous monitoring of environment. An illustrative case involving an uncertain compensation claim of a radiation worker who had used a film badge is examined in depth. (C.O.)

29762 (DMRE-69-3, pp 172-9) RADIATION RECORDS-KEEPING IN NUCLEAR MEDICINE. Burdine, John A. Jr.; Morgan, Karl H. (Baylor Univ., Houston, Tex. Dept. of Radiology).

Patient radiation exposure from diagnostic radioisotope scanning and therapeutic radioisotope exposures are discussed. The actual and potential hazards of these procedures are considered in relation to the basic biologic effects of radiation. It is stated that the approach using the principle that the lowest possible exposures should be maintained since radiation as such does not produce any beneficial effects to normal tissue. Special care should be taken when the patient is a child. Record keeping is discussed along with the reasons for maintaining radiation records. It is concluded that until a satisfactory means for estimating absorbed radiation dose in man, an accurate scheme for transposition of this data into biologic effects, and the true risks involved in diagnostic nuclear medicine become available, the purpose for exposure record maintenance in patients will have to remain as a means of providing rather crude information for scientists of the future. (C.O.)

29763 (DMRE-69-3, pp 192-200) CASE HISTORIES OF COMPENSATION FOR RADIATION EMPLOYEES. Tinsley, Thomas A. (Bureau of Employees' Compensation, Washington, D. C.).

Workmen's compensation law, especially as it relates to federal jurisdiction, is reviewed, and basic information needed in compensation cases is listed. Two cases involving possible radio-induced injuries are presented in detail. These examples have stimulated both pro and con reaction to the decisions that were made. It was observed from the review of compensation cases that present methods, practices, and devices do not adequately provide measurements and information concerning radiation exposure. The better the basic information, the more adequate, accurate, and reliable the exposure data, the better the conclusions and the decisions will be in a particular case. (C.O.)

29764 (DMRE-69-3, pp 226-37) TORT LIABILITY IN RADIATION CASES. Tressler, David L. (American Mutual Reinsurance Co., Chicago, Ill.).

The medical and legal problems of radiation cases are reviewed. The role of the insurance industry and its contributions to the development of peaceful uses of atomic energy are discussed. The formation of nuclear insurance pools for the purpose of amassing insurance capacity to meet potential damages resulting from liability due to the operation of licensed nuclear facilities is described. Unique aspects of the policy covering nuclear hazards are listed and the provisions of the Price–Anderson Amendment are discussed. Further amendments that have been proposed are also presented. (C.O.)

29765 (DMRE-69-3, pp 238-48) FIXING RESPONSIBILITY FOR RADIATION INJURIES STEMMING FROM MULTIPLE SOURCES. White, A. A. (Houston Univ., Tex. Bates Coll. of Law).

The approach of the common-law courts in fixing the responsibility for injuries emanating from multiple sources and involving more or less tangible substances is outlined using situations where: two or more persons negligently or intentionally act in concert to produce a particular result; two negligent defendants act independently to cause a single indivisible injury; each negligent defendant acts independently; two negligent defendants, each of whom caused some, but not all, of a single indivisible result; defendants who act independently, each making a contribution that alone would cause no damage, but which, when combined, produce a single indivisible injury. Some of the unique features of radiation injuries that contribute to the difficulties in establishing negligence and causation, particularly where there are known or suspected multiple sources, are listed. These include differences in sensitivity, the cumulative nature of radiation injury, possibility of emergence of injuries staggered over long periods of time, different degrees of relation to the exposure, difficulty of placing exposure in time, long delay period, proof of dose, and the fact that radiation is one of the most likely causes of certain injuries (prenatal, sterility, shorter life span, susceptibility to disease). One proposal on handling radiation injuries that operates

on an insurance principle is discussed. The difficulties foreseen in the operation of such a plan are presented and a suggested method using Federal Government aid in notifications, recording exposures, and compensation is described. (C.O.)

29766 (DMRE-69-3, pp 256-65) PROBLEMS OF LEGAL PROOF IN RADIATION CASES. O'Toole, Thomas J. (Northeastern Univ., Boston, Mass. School of Law).

The use of the term causation by the legal and medical professions is discussed. The medical profession is not certain that the cause of a disease is known unless the biochemical processes that bring it about are known exactly. In the courtroom the inquiry into causation is a reflection of social purposes and not merely of biochemical knowledge. It is felt that the medical notion of causation, while of interest to a court of law, should not be controlling when the real nature of the legal notion of causation is explored. It is stated that by allowing the medical view to dictate the result of radiation claims, the legal process is not only abdicating its responsibility to apply the policy of the workmen's compensation statutes, but is also allowing the unexpressed policy judgments of the medical expert witness to influence the result. In cases of workmen's compensation the laws should be liberally interpreted to protect the employee, keeping in mind that the employers have been immunized against common law liability. Although it is proper for men of medicine to reserve judgment on causation, this is not a proper basis for denial of compensation by courts of law. In cases of negligence, there is the need for proof of negligence and there is no public policy that supports preference for the plaintiff. Brief discussion is presented on two other matters of concern in legal proceedings involving radiation injuries. One concerns radiation measurements; they are presented in mathematical terms as evidence and tend to receive a degree of respect in excess of what the underlying facts would warrant. The other concern involves the sometimes unrealistic courtroom treatment of safety standards; they were never intended as indications of the level of absolute safety. (C.O.)

29767 (DMRE-69-3, pp 266-82) DOCTRINE OF RES IPSA LOQUITUR IN RADIATION INJURIES. Houser, Franklin D.

The history of the doctrine of res ipsa loquitur (the thing speaks for itself) is reviewed, and a list of jurisdictions recognizing the Wigmore definition is included. Problems in applying this principle to cases of radiation injuries are discussed and an example of tort application is presented. The primary point that the causation, not negligence, is the basic problem in negligent radiation exposure cases is made. Suggestions are made for the successful handling of radiation cases by lawyers: familiarization with existing and required radiation records; scientific approach; and understanding of radiation and the atomic age. Cases regarding radiation injury are reviewed and it is concluded that where causation is shown, there has been no lack or want of the judicial process to impose liability and the court-conferred compensation. It is felt that the res ipsa loquitur principle will operate effectively in radiation injury cases when science has progressed to be able to establish with a degree of certainty the relation between radiation exposure and any alleged lesion resulting therefrom. (C.O.)

29768 (DMRE-69-3, pp 283-93) RADIATION RECORDS: THE PLAINTIFF'S CASE. Kronzer, W. James.

The limitations that the courts impose on the receipt of records of any kind, and the reasons for these proscriptions are reviewed in relation to the value of radiation records to the plaintiff. Problems of authenticity, trustworthiness, reliability of records, hearsay evidence, and expert testimony are discussed. Although there are offsetting factors, it is concluded that the collection and availability of information carried without opinion and comment would be of great value to persons sustaining radiation injuries, or who suffer from diseases that are arguably traceable to radiation exposure. (C.O.)

29769 (DMRE-69-3, pp 294-303) RADIATION RECORDS: THE DEFENDANT'S CASE. Alexander, Thomas.

The importance of keeping radiation records from the viewpoint of the defendant is evaluated. The necessity of recording facts and of not recording opinions is discussed. Problems of privilege questions, expert testimony, clearness of purpose in keeping records, and care in keeping and filing records are discussed. It is concluded that records may be of great value as a vehicle toward truth, but have little value in themselves. (C.O.)

29770 (DMRE-69-3, pp 314-27) STATUTES OF LIMITATIONS IN TORT CLAIMS: MEDICAL ASPECTS. Cox, John L. Jr. (Houston Univ., Tex. Bates Coll. of Law).

A number of cases are reviewed in which statutes of limitations problems arose in a medical situation. The fixing of the time at which statutes of limitations go into effect has undergone several changes. The substantial shortcomings that exist in the application of such statutes in cases involving latent injuries are pointed out. Claims for injuries arising out of radiation exposure are subject to the various state statutes that have given rise to completely inconsistent approaches and results in the resolution of these controversies. Some of these cases have visited gross injustices upon meritorious claimants and imminent authority has recognized and made recommendations for statutory revisions leading to consistency of results coupled with fairness to the parties involved. The suggested state legislation proposed by the committee of state officials on suggested state legislation of the council of state governments is given. (C.O.)

29771 (DMRE-69-3, pp 328-48) STATUTES OF LIMITATIONS IN COMPENSATION CLAIMS. Kalmykow, Andrew (American Insurance Association, New York).

Workmen's compensation laws are discussed in relation to their applicability to radiation injuries and time limits. The problems of traumatic or accidental injury versus occupational disease and the time element, knowledge of exposure, reporting of injury, and law requirements are outlined. Much legislative activity has occurred in the United States since 1959, so that problems of time limitations have been minimized or completely eliminated by appropriate legislation in nearly all states. Four appendixes provide details concerning: compensation for radiation injuries in accidents or occupational disease (by states); time limits for compensation for radiation injuries (limitations not related to exposure) (by states); time within which disability or death must occur after exposure (by states); and partial listing of decisions relating to time limitations in latent injury cases (listed by states). (C.O.)

29772 (DMRE-69-3, pp 349-61) STATUTORY CONTROL OF RADIATION RECORDS. Huard, Leo A. (Santa Clara Univ., Calif. School of Law).

The needs and lack of progress in universal radiation record keeping are analyzed. The concept of legally valid records, the requirements of the law of evidence, i.e., relevancy, competency, and materiality, and the lack of understanding of these needs on the part of the record keepers (doctors, technicians, etc.) are considered. The focus is on patient and personnel dose during diagnostic x-ray examinations, patient and personnel dose during radiotherapy, and patient and personnel dose during radioisotope procedures. The problem of control over the records is discussed in three contexts: a nationwide federal statute; uniform state laws; and state laws enacted independently in each state. It is recommended that a model medical radiation-exposure record keeping act be drawn up by concerned radiological health people and interested lawyers. This model act could be presented to state legislatures of the more populous states. After some experience, revisions should be made and provisions for further revision to fit changing situations must be considered. (C.O.)

29773 (DMRE-69-3, pp 363-82) ADDITIONAL SUBMISSIONS: APPENDIX A.

Participants in the conference were invited to submit additional comment for possible inclusion in the published proceedings. Eight of the letters submitted are appended. (C.O.)

29774 FORENSIC PROBLEMS IN CONNECTION WITH IONIZING RADIATIONS. Pulcinelli, M. (Univ., Pisa, Italy). G. Fis. Sanit. Prot. Radiaz.; 12: No. 3, 168-78(1968). (In Italian).

Some of the medicolegal aspects of radiation lesions are considered, and some of the more important problems that may arise are illustrated. The extreme fluidity and uncertainty that exists in this sector of forensic medicine at the present time is stressed, including the fact that no suitable legislation or a valid jurisprudence has yet emerged. A phase of legislative deficiency exists, but the spread and consequences of the use of ionizing radiations in modern social life impose an urgency on legislators and scientists to provide appropriate laws to safeguard the elementary civil and social rights of society. (Excerpta Med.)

Medicine

Refer also to abstracts 29762, 29770, and 29773.

29775 (DMRE-69-3, pp 184-91) ADMINISTRATIVE ASPECTS OF RADIATION RECORDS-KEEPING. Collins, Stephen B. (Rosewood General Hospital, Houston, Tex. [Radiotherapy Center]).

The following conclusions were drawn. The keeping of radiation records is the responsibility of the hospital. The hospital administrator must ensure that radiation records are being maintained. Radiation records should be both medically significant and economically feasible. Because of the hazards asso-

ciated with radiation, good records will afford the institution as much protection from litigation as is humanly possible, although the institution is a potential target of litigation from several angles. The administrator must look to the physicians and other experts in the field of radiation to determine what a medically significant system of radiation records is. If the records are compiled on a routine basis, one cannot help being continually aware of the hazards that exist. (auth)

29776 (UCRL-18793) BIOLOGY AND MEDICINE. Semiannual Report, Fall 1968. Lawrence, John H. (ed.) (California Univ., Berkeley. Lawrence Radiation Lab.). Contract W-7405-eng-48. 146p. Dep. CFSTI.

Separate abstracts were prepared for 15 papers for inclusion in NSA. The remaining six papers included basic studies of nervous tissues in cultures, fluorescence of lipoproteins, ultracentrifuge data acquisition, scanning electron microscopy, and urinary erythropoietin assay. (C.O.)

For abstracts of individual papers see: 29580, 29696–29699, 29709, 29748, 29787, 29788, 29821, 29843–29845, 29892, and 29894.

Protective Substances

Refer also to abstracts 29702 and 29736.

29777 THE PARADOXICAL ACTION OF A RADIOPROTECTIVE SUBSTANCE ON MITOSIS AND ON THE CHROMOSOMES IN VITRO. Delrez, M.; Firket, H. (Univ., Liege). Biochem. Pharmacol.; 17: 1893-9(1968). (In French).

The effect of increasing doses (0.27 to 35.2 mM) of mercaptamine (2-mercaptoethylamine or cysteamine) on the mitotic index and the chromosomes was studied in cultures of Chinese hamster fibroblasts. Consistent results were obtained from seven separate experiments. At 1.1 mM concentration, mercaptamine induced chromatid breaks 2 hr after the end of a 60 min treatment. With the same dose, the mitotic index was reduced for several hours after the treatment. However, with a doubled dose, mitotic index and mean number of chromatid breaks were the same as in control cultures. At higher doses (8.8 to 35.2 mM), these modifications reappeared but they were less statistically significant. The results are discussed in relation to the hypothesis of a reversible formation of mixed disulfides with proteins. (Excerpta Med.)

29778 AET EXCHANGE. II. UPTAKE AND METABOLISM OF PERORALLY INTRODUCED ^{14}C-AET IN MICE ORGANISM. Sztanyik, Laszlo; Mandi, Erika. Honvedorvos, 21: 41-7(Jan.-Mar. 1969). (In Hungarian).

Following up earlier studies on the metabolism of peritoneally injected AET in mice, the effect of orally administered AET was investigated, using a ^{14}C-labeled compound with an activity of 0.88 μCi; the activity introduced into the animals amounted to about 5 μCi. Measurements of the specific activity indicated that in the first half-hour the stomach wall contained 50 times, the small intestines 2 to 4 times and the large intestines 2 to 3 times of the radioprotective agent that could be expected on the basis of uniform distribution. The mortality of mice exposed to lethal doses was reduced to the largest extent when AET was administered, either intraperitoneally or perorally, 15 minutes before exposure; this ensures that the organs will contain the largest possible amount of the protective agent. The peroral administration extended the absorption of AET. (TTT)

29779 ON LIVER PROTECTION THERAPY DURING ^{60}Co IRRADIATION OF LIVER METASTASES. Kleinert, H. (Univ., Heidelberg). Ther. Gegenw.; 107: 1648-53(Dec 1968). (In German).

Twelve patients with liver metastases received approximately 4,000 r total dose of cobalt-60 γ radiation to the hepatic area. In addition to the conventional treatment, the combination of two amino acids, ornithine and aspartate, was administered orally and intravenously following exposure. All patients so treated showed an improved radiation tolerance as indicated by reduced nausea, anorexia, and apathy. It was assumed that the amino acid combination enhances detoxifying actions of the liver, especially the elimination of toxic substances produced by radiation. (H.B.G.)

Radiation Sickness and Injuries

Refer also to abstract 29711.

29780 (UCD-472-116, pp 50-2) TREATMENT PHILOSOPHY, COLONY STATUS, AND CLINICAL OBSERVATIONS. Hosein, Amy A.; Dollarhide, Nancy K.; Bulgin, Marie S. (California Univ., Davis. Radiobiology Lab.).

The rationale for the clinical treatment of the beagle colony is presented, and clinical cases for the past year are reviewed. Approximately 50 radiation-induced and 200 other disorders were treated. The majority of losses in the high ^{226}Ra exposure groups were due to osteosarcomas; dogs at high levels of ^{90}Sr died mainly with myeloproliferative disorders. (auth)

29781 EFFECT OF PHEOPHYTIN ON THE COURSE OF EXPERIMENTAL RADIATION LEUKOPENIA. Novoselova, G. S.; Frolov, S. F.; Chernomorskii, S. A.; Kurnygina, V. T. Nauch. Tr., Leningrad. Lesotekh. Akad.; No. 119, 93-4(1969). (In Russian).

Male rats weighing 180 to 190 g were exposed to whole-body γ irradiation with a dose of 350 R. Six hr later the rats were injected subcutaneously every day for 4 days with pheophytin (2 mg/kg). Peripheral blood was examined 2 to 3 days after exposure for 28 days. In the group of treated rats, the leukocyte count returned to normal 13 days after irradiation, but in the control group, the count at this time was 65% of the original level. However, the treated animals again suffered from leukopenia for 15 to 18 days after irradiation. On day 24 the leukocyte count in both groups returned to the original level. Pheophytin is believed to promote the rapid release of mature elements from bone marrow. (JPRS)

29782 THERAPY OF IRRADIATION-INDUCED LEUKOPENIA WITH ESBERITOX. Pohl, P. (Katharine-Hospitals, Stuttgart). Med. Klin. (Munich); 64: 1546-7(1969). (In German).

Fifty five advanced cancer patients were treated with high-energy electrons, hard x-rays, and ^{60}Co γ radiation. During radiation therapy, Esberitox was administered. Patients under Esberitox treatment showed a significantly smaller reduction in leukocyte count. The increased leukocyte count persisted throughout the combination treatment. It was concluded that Esberitox directly stimulates leukopoiesis. (H.B.G.)

Radiodiagnosis

Refer also to abstracts 29233, 29618, 29623, 29627–29634, 29636–29641, 29647, 29649–29676, 29696, 29699, 29701, 29746, 29749, 29751, 29754, 29755, 29761, and 29886.

29783 (DMRE-69-3, pp 96-129) PATIENT AND PERSONNEL DOSE DURING DIAGNOSTIC X-RAY EXAMINATIONS. Webster, Edward W. (Harvard Medical School, Boston, Mass.).

The methods available and information required for estimating the radiation dose received by patients undergoing diagnostic x-ray examinations and by persons occupationally exposed to radiation through the administration of such examinations are discussed. Several kinds of dose estimates are desirable depending on the nature of the disability under consideration: the maximum and mean dose received by the tissues in which the disability occurs; the mean whole-body dose received in utero or postnatally; and the ovary dose received by a mother in the early stages of pregnancy. The accuracy required in dose estimates is discussed in detail. Tables and examples of records are provided for the patient and the personnel situations. (C.O.)

29784 (UCD-472-116, pp 39-40) ^{18}F SCANNING FOR VISUALIZATION OF ^{226}Ra INDUCED BONE LESIONS. Goldman, M.; Williams, R. Jean Romer; Bulgin, Marie S. (California Univ., Davis. Radiobiology Lab.).

^{226}Ra-induced periosteal lesions, fractures, and tumors are identified as hot spots in ^{18}F scans of beagles. Diminished fluorine uptake patterns in bone may reflect bone vascular injury. (auth)

29785 (UCD-472-116, pp 105-7) RENAL FUNCTION STUDIES. Della Rosa, R. J.; Buddingh, Fred (California Univ., Davis. Radiobiology Lab.).

Renal function parameters can be determined from analysis of plasma disappearance curves following a single intravenous injection of ^{125}I radiohippuran. This method offers a nontraumatic procedure for assessing radiation-induced kidney damage. (auth)

29786 (UCD-472-116, pp 125-6) EVALUATION OF FETAL LAMB THYROID FUNCTION. Della Rosa, R. J.; Ishizaki, Goro; Buddingh, Fred (California Univ., Davis. Radiobiology Lab.).

Evaluation of fetal thyroid function using ^{125}I is feasible utilizing a surgical preparation for externalizing the fetal urine, blood and amnionic fluid. (auth)

29787 (UCRL-18793, pp 80-5) THE SYNTHESIS OF SODIUM ^{11}C-BENZOATE AND ITS USE IN RENAL VISUALIZATION. Winstead, Meldrum B.; Winchell, H. Saul; Fawwaz, Rashid A. (California Univ., Berkeley. Lawrence Radiation Lab.).

Carbon-11 is a positron-emitting radioisotope with a $t_{\frac{1}{2}}$ of 20.4

min. This short $t_{\frac{1}{2}}$ allows for administration of large quantities of ^{11}C-labeled compounds with minimal radiation dose to the patient, and the positron emission provides for great discrimination in determining its localization in the body. To utilize these virtues, we are developing methods for rapid syntheses of medically useful ^{11}C-labeled compounds. The use of sodium ^{11}C-benzoate in renal visualization is reported. Deuteron bombardment of a B_2O_3 target $^{10}B(d,n)^{11}C$ yields ^{11}CO and $^{11}CO_2$ liberated from the target by recoil. The ^{11}CO is oxidized to $^{11}CO_2$ in the gas phase and is reacted with phenylmagnesium bromide to form, after acid hydrolysis and extraction with $NaHCO_3$, sodium ^{11}C-benzoate. Yield is 60–80% of ^{11}C produced and trapped by the Grignard reagent, and preparation time is 10 to 20 minutes. When injected IV in dogs, the ^{11}C is rapidly excreted by the kidneys. Positron camera pictures of the kidneys, using this material, demonstrate a sufficiently long parenchymal filling phase (during first 10 min after injection) to allow for tomographic visualization of renal parenchyma, which appears to have advantages for lesion detection over ^{203}Hg-chlormerodrin. Positron camera tomograms taken during the filling phase of the renal pelvis also appear to show greater detail than obtained with ^{131}I-iodohippurate. (auth)

29788 (UCRL-18793, pp 118-27) WHOLE-BODY MARROW DISTRIBUTION STUDIES IN POLYCYTHEMIA VERA. Van Dyke, Donald C.; Lawrence, John H.; Anger, Hal O. (California Univ., Berkeley. Lawrence Radiation Lab.).

One-fifth to $\frac{1}{3}$ of all patients with polycythemia die from marrow failure. Total-body marrow-distribution studies using ^{52}Fe in 23 patients in various stages of polycythemia vera indicate that although some peripheral extension of marrow characteristically occurs early in the course of the disease, the process is not a slowly progressive one, but remains stable during most of the active stage of the disease. Progressive degeneration of the marrow pattern probably precedes the "burned out" stage, and provides the physician with prognostic information which may prove helpful in management of the disease. Because of its 8-hr half-life and the necessity of cyclotron production, ^{52}Fe is not generally available at present. For this reason patterns for ^{99m}Tc-sulfur colloid and for ^{52}Fe were compared. Comparisons to date indicate that the use of iron or colloid gives essentially the same total body marrow-distribution pattern in the majority of cases. (C.O.)

29789 BRAIN TUMOR SCANNING WITH RADIOISOTOPES. Proceedings of a Symposium Held in Buffalo, New York, May 23–24, 1968. Bakay, Louis; Klein, David M. (eds.). Springfield, Ill.; Charles C Thomas, Publisher (1969). 225p. (CONF-680561).

Separate abstracts were prepared on 13 papers presented at this symposium. (C.H.)

For abstracts of individual papers see: 29790–29802.

29790 BASIC ASPECTS OF THE ACCUMULATION OF SUBSTANCES IN BRAIN TUMORS. Bakay, Louis (State Univ. of New York, Buffalo). pp 5-20 of Brain Tumor Scanning With Radioisotopes. /Bakay, Louis (ed.). Springfield, Ill.; Charles C Thomas (1969).

From Symposium on Brain Tumor Scanning With Radioisotopes, Buffalo, N. Y. See CONF-680561.

Factors affecting the uptake of radioisotopes and radioisotope-labeled compounds by brain tumors following parenteral administration are discussed. The influence of the blood content of tumor tissue, the abundance and structure of neoplastic blood vessels, the permeability of central nervous system membranes, the size of extracellular space in brain tumors, tumoral and peritumoral edema, and metabolic factors that influence the differential uptake of radioisotopes by malignant cells in the brain are discussed. It is pointed out that truly selective uptake of any agent by brain tumors has not been demonstrated. (C.H.)

29791 FACTORS INVOLVED IN THE UPTAKE AND DISTRIBUTION OF RADIOACTIVE TRACERS IN BRAIN TUMORS AND BRAIN. Tator, Charles H. (Univ. of Toronto). pp 21-36 of Brain Tumor Scanning With Radioisotopes. /Bakay, Louis (ed.). Springfield, Ill.; Charles C Thomas (1969).

From Symposium on Brain Tumor Scanning With Radioisotopes, Buffalo, N. Y. See CONF-680561.

Factors that affect the uptake and distribution of radioisotope-labeled compounds in brain tumors and normal brain tissues are discussed. Data are included on the differential uptake of ^{198}Au, ^{59}Fe, ^{203}Hg, ^{125}I, and ^{131}I in normal and brain tumor tissues following administration in 19 labeled compounds. The uptake of radioactivity by brain tumors following the injection of ^{131}I-labeled serum albumin (RISA) is discussed in detail. It is pointed out that many mechanisms, including cellularity, vascularity, increased capillary permeability, and breakdown of the blood-brain barrier, have been postulated to account for the uptake of radioisotope-labeled compounds by brain tumors, but the significance of these factors remains uncertain. It is concluded that the ideal radioactive tracer for the localization and elucidation of the pathological nature of brain tumors has not yet been found. (C.H.)

29792 CONCENTRATION OF TRACER SUBSTANCES IN BRAIN TUMORS: AN ELECTRON MICROSCOPIC EVALUATION. Raimondi, Anthony J. (Univ. of Illinois, Chicago). pp 37-45 of Brain Tumor Scanning With Radioisotopes. /Bakay, Louis (ed.). Springfield, Ill.; Charles C Thomas (1969).

From Symposium on Brain Tumor Scanning With Radioisotopes, Buffalo, N. Y. See CONF-680561.

The ultrastructural characteristics of capillaries, glial cells, neuronal cells, and axons in both gray and white matter of the normal brain are reviewed; and changes induced by neoplasms observed by electron microscopy are described. Mechanisms involved in the uptake of ^{131}I-labeled serum albumin (RISA) from the blood by neoplastic cells are discussed. (C.H.)

29793 CORRELATION BETWEEN THE ULTRASTRUCTURE OF BRAIN TUMORS AND THEIR UPTAKE OF ^{203}Hg-CHLORMERODRIN. Bakay, Louis (State Univ. of New York, Buffalo); Kung, Patrick C.; Lee, Joseph C. pp 47-55 of Brain Tumor Scanning With Radioisotopes. /Bakay, Louis (ed.). Springfield, Ill.; Charles C Thomas (1969).

From Symposium on Brain Tumor Scanning With Radioisotopes, Buffalo, N. Y. See CONF-680561.

The morphology of cells of human glioblastomas localized by ^{203}Hg-chlormerodrin scanning was compared with that of glioblastomas with a negative scan. A significant difference in the ultrastructure of the glioblastomas was observed using electron microscopy. It was concluded that the discrepancy in scanning results was caused by differences in vascular permeability and the effect of tumor cells on the surrounding brain tissue. (C.H.)

29794 BIOPHYSICAL ASPECTS OF BRAIN TUMOR SCANNING. Brownell, Gordon L.; Wilensky, Samuel; Ashare, Alan; Burnham, Charles A. (Massachusetts Inst. of Tech., Boston. Massachusetts General Hospital, Boston). pp 79-86 of Brain Tumor Scanning With Radioisotopes. /Bakay, Louis (ed.). Springfield, Ill.; Charles C Thomas (1969).

From Symposium on Brain Tumor Scanning With Radioisotopes, Buffalo, N. Y. See CONF-680561.

The development of radiation detection instruments for the visualization of parenterally administered radioisotopes in man is reviewed. Data processing and data display systems using computers for the analysis of radioisotope scan data are described. (C.H.)

29795 NEW POSITRON SCANNING TECHNIQUES. Burnham, Charles A.; Aronow, Saul; Wilensky, Samuel; Brownell, Gordon L. (Massachusetts General Hospital, Boston). pp 87-95 of Brain Tumor Scanning With Radioisotopes. /Bakay, Louis (ed.). Springfield, Ill.; Charles C Thomas (1969).

From Symposium on Brain Tumor Scanning With Radioisotopes, Buffalo, N. Y. See CONF-680561.

Design features of a nine-detector-pair scintillation scanner with coincidence circuit for use in the visualization of the distribution of γ radiation from positron-emitting radioisotopes in man are described. Applications in human brain scanning using ^{74}As are reported. (C.H.)

29796 RADIOPHARMACEUTICAL EVALUATION OF AGENTS USED FOR SCANNING. Blau, Monte (Roswell Park Memorial Inst., Buffalo). pp 101-7 of Brain Tumor Scanning With Radioisotopes. /Bakay, Louis (ed.). Springfield, Ill.; Charles C Thomas (1969).

From Symposium on Brain Tumor Scanning With Radioisotopes, Buffalo, N. Y. See CONF-680561.

The physical and biological properties of radioisotope-labeled compounds for brain scanning are reviewed. The dependency of tumor visualization on the γ energy of the radioisotope used is discussed and the energy levels of 10 radioisotopes used for scanning are considered. Results of scanning studies using a phantom of a tumor-bearing human head in combination with the 10 different radioisotopes, various collimators, and scintillation scanner or γ camera are reported. It is pointed out that all the radioisotopes localize in brain tumors, with the time scale different for each labeled compound. Factors affecting tumor uptake include tumor vascularity, the breakdown of the blood-brain barrier membrane; and cellular uptake. At present protein-bound radioisotopes offer the best possibility for prolonged tumor uptake with decreasing blood levels. (C.H.)

29797 CLINICAL EXPERIENCE WITH RISA IN TUMOR DETECTION. Planiol, Therese (Centre Hospitalier Regional Bretonneau, Tours, France). pp 111-19 of Brain Tumor Scanning

With Radioisotopes. /Bakay, Louis (ed.). Springfield, Ill.; Charles C Thomas (1969).

From Symposium on Brain Tumor Scanning With Radioisotopes, Buffalo, N. Y. See CONF-680561.

Clinical experience over a 13-year period in which 11,000 patients were examined for the detection of brain tumors using radioisotope scanning is reviewed. Changes in scanning techniques are discussed. The compounds used included ^{131}I-serum albumin, ^{203}Hg-chlormerodrin, ^{197}Hg-chlormerodrin, ^{99}Tc-pertechnetate, and ^{99}Tc-serum albumin. A comparison of results led to the conclusion that any choice of a labeled compound is the result of a compromise, but the use of ^{131}I-serum albumin over a 10-year period resulted in a large number of correct diagnoses as far as localization and etiology of the lesions were concerned. (C.H.)

29798 RADIOISOTOPIC SCANNING WITH POSITRON-EMITTING ISOTOPES. Ojemann, Robert G.; Sweet, William H. (Massachusetts General Hospital, Boston). pp 121-39 of Brain Tumor Scanning With Radioisotopes. /Bakay, Louis (ed.). Springfield, Ill.; Charles C Thomas (1969).

From Symposium on Brain Tumor Scanning With Radioisotopes, Buffalo, N. Y. See CONF-680561.

Clinical results using the positron-emitting radioisotopes ^{74}As and ^{64}Cu and dual scintillation detectors with coincidence circuits for the localization of brain tumors are reported. Over 7,000 patients were examined during a 15-year period. Best results were obtained using ^{74}As-arsenate. The effectiveness of ^{74}As-arsenate and ^{99m}Tc-pertechnetate scanning for the localization of brain tumors was compared. Results are included from recent studies using ^{68}Ga and ^{18}F with positron cameras for the localization of brain tumors. (C.H.)

29799 CONTOUR BRAIN SCANNING AND RADIOISOTOPIC CIRCULATION STUDIES FOR DIFFERENTIATING CEREBROVASCULAR LESIONS AND TUMORS. Yamamoto, Y. Lucas; Feindel, William H. (McGill Univ., Montreal. Montreal Neurological Inst.). pp 141-67 of Brain Tumor Scanning With Radioisotopes. /Bakay, Louis (ed.). Springfield, Ill.; Charles C Thomas (1969).

From Symposium on Brain Tumor Scanning With Radioisotopes, Buffalo, N. Y. See CONF-680561.

The value of external measurements of the distribution of radioactive tracers for the diagnosis of nonneoplastic brain lesions as well as the localization of brain tumors is discussed. Factors affecting the differential uptake of radioactive tracers by brain lesions are reviewed. Data are reported on the effectiveness of intravenous radioisotope circulation studies as a means of differentiating between tumors and cerebrovascular lesions using an automatic contour scanner with matched twin-scintillation detectors which simultaneously scan two similar regions on either side of the head in a series of concentric arcs. Results are reported from a comparative study on the effectiveness of ^{197}Hg-chlormerodrin, ^{203}Hg-chlormerodrin, ^{131}I-serum albumin, and ^{99}Tc-pertechnetate for brain scanning to differentiate neoplasms and vascular lesions. Analysis of turnover rates on repeated scans indicated the retention of ^{197}Hg-chlormerodrin and ^{131}I-serum albumin in neoplastic tissue is the result of different physiochemical mechanisms. The differential uptake as measured from contour scans repeated following a single injection of radioisotope gave some indication of the type of cerebrovascular lesion and a decreasing percentage of differential uptake on repeated injections and scanning at intervals of days or weeks indicated cerebral infarct as opposed to cerebral tumor. A single repeatable technique using a single intravenous injection of radioisotope and separate detectors to measure cerebral circulation transit curves was combined with contour scanning to help differentiate between cerebrovascular occlusive disease and brain tumors. Examples of the application of the scanning method and combined scan-circulation transit curve method are reported. (C.H.)

29800 DIFFERENTIAL DIAGNOSIS OF NEOPLASTIC AND NON-NEOPLASTIC DISEASE ON THE BASIS OF RADIOISOTOPIC BRAIN SCANNING. Leslie, Eugene V.; Alker, George J. Jr.; Bakay, Louis (State Univ. of New York, Buffalo). pp 169-86 of Brain Tumor Scanning With Radioisotopes. /Bakay, Louis (ed.). Springfield, Ill.; Charles C Thomas (1969).

From Symposium on Brain Tumor Scanning With Radioisotopes, Buffalo, N. Y. See CONF-680561.

The value of radioisotope brain scanning for the differential diagnosis of neoplastic and nonneoplastic brain lesions is discussed. Mechanisms responsible for the temporal and spatial uptake of various molecules, such as ^{131}I-serum albumin and ^{197}Hg- or ^{203}Hg-chlormerodrin, in infarcts and neoplasms are discussed. The value of the clinical history and examination, cerebrospinal fluid findings, electroencephalography, echoencephalography, and various radioisotope techniques including section scanning, rapid sequential scanning, contour scanning, radioisotope circulation and washout studies, and ^{131}I serum albumin scanning, in addition to ^{197}Hg- or ^{203}Hg-chlormerodrin scanning is discussed. Experience with about 2,000 brain scans using ^{203}Hg-chlormerodrin and a rectilinear scanner with a 3-in. scintillation crystal and 19-hole collimator led to the conclusion that neoplastic and nonneoplastic intracranial lesions can be distinguished on a single positive scan in a high percentage of cases and on most occasions the nature of the cerebral infarct can be determined. (C.H.)

29801 BRAIN TUMOR SCANNING IN CHILDREN. Mealey, John Jr.; Mishkin, Fred S. (Indiana Univ., Indianapolis). pp 187-200 of Brain Tumor Scanning With Radioisotopes. /Bakay, Louis (ed.). Springfield, Ill.; Charles C Thomas (1969).

From Symposium on Brain Tumor Scanning With Radioisotopes, Buffalo, N. Y. See CONF-680561.

Results of brain scanning for tumor localization in 50 children are reported in which ^{99}Tc-pertechnetate was used as the tracer. No harmful side effects or complications were observed during a five-year period. The whole-body radiation dose was estimated at 17 mrads/100 μc of ^{99}Tc-pertechnetate in a newborn, decreasing to 6 and 2.4 mrads/100 μc at one and 10 years of age. The overall scanning accuracy in this series was 54%. Techniques used are described. Results of brain scans in additional children using ^{131}I-serum albumin, ^{197}Hg-chlormerodrin, or ^{203}Hg-chlormerodrin as tracer are also described. (C.H.)

29802 RADIOACTIVE BRAIN SCANS COMPARED TO OTHER DIAGNOSTIC TECHNIQUES. Bucy, Paul C.; Ciric, Ivan S. (Northwestern Univ., Chicago). pp 201-10 of Brain Tumor Scanning With Radioisotopes. /Bakay, Louis (ed.). Springfield, Ill.; Charles C Thomas (1969).

From Symposium on Brain Tumor Scanning With Radioisotopes, Buffalo, N. Y. See CONF-680561.

The effectiveness of brain scans, using ^{197}Hg- or ^{203}Hg-labeled chlormerodrin or ^{99}Tc-pertechnetate, for the diagnosis of neoplastic and non-neoplastic brain lesions was compared with other diagnostic procedures in a series of 100 cases. The other diagnostic methods included roentgenograms, pneumoencephalograms, ventriculograms, cisternograms, cerebral angiograms, and electroencephalograms. It was concluded that radioisotope brain scans are the most important single diagnostic adjunct in the recognition and localization of intracranial tumors, however, none of the diagnostic tests are perfect. (C.H.)

29803 DEVELOPMENT OF DIAGNOSTIC CRITERIA IN ECHOGRAPHIC STUDY OF ABDOMINAL LESIONS. Freimanis, Atis K.; Asher, W. Michael (Ohio State Univ., Columbus). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 747-55(Apr 1970).

Based on the experience with over 600 abdominal B-scan echograms, diagnostic principles and signs are discussed. These include: requirements for complete mapping of the abdomen; and demonstration of the lesion in scans obtained in two planes and at several instrument sensitivity settings. Certain characteristic echographic appearances can be correlated with the underlying pathophysiologic or anatomic changes and are discussed as echographic signs. These include: the through-transmission sign; the mass outline sign; the double contour sign; the absent contour sign; the compressed tissue sign; the intraorgan echo sign; and the distribution pattern sign. The use of echographic scanning as a diagnostic method rather than as a novel display of known pathology cannot be overemphasized. Systematic approach to patient examination and scan interpretation is needed for consistent and correct diagnoses. (auth)

29804 SCINTIPHOTOGRAPHY OF REGIONAL MYOCARDIAL BLOOD FLOW IN THE NORMAL AND INFARCTED HEART. Johnson, Philip M.; Cannon, Paul J.; Haft, Jacob I. (Columbia Univ., New York). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 708-15(Apr 1970).

The distribution of coronary arterial blood within the myocardium was visualized in the dog by rapid scintillation imaging after injection of ^{133}Xe into the left coronary artery or its branches. Acute myocardial infarction was then induced by a closed-chest method and the myocardial distribution of coronary arterial blood was revisualized. The postinfarction distribution of coronary arterial blood was smaller and configurationally altered in comparison to the distribution in the normal state. The method appears to have potential application to detection of regional myocardial ischemia in man. (auth)

29805 REGIONAL PULMONARY FUNCTION IN MAN. QUANTITATIVE TRANSMISSION RADIOGRAPHY AS AN ADJUNCT TO LUNG SCINTISCANNING. Potchen, E. J.; Evens, R. G.; Hill, R.; Adatepe, M.; Holman, L.; Lindeman, J.; Markham, J. (Washington Univ., St. Louis). Contract AT(11-1)-1653. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 724-8(Apr 1970).

A new technique using quantitative transmission radiography affords a clinical assessment of regional pulmonary function in man. This was useful as an adjunct to perfusion lung scintiscanning with ^{99m}Tc by identifying the change in thoracic density during respiration, thus allowing us to distinguish some patients with altered regional perfusion due to inhomogeneous ventilation from those with normal ventilation and diminished perfusion owing to pulmonary embolism. The method proposed is far simpler than either radioactive gas or particle inhalation techniques. In addition, the computer processing may well permit data storage (to define the limits of normal) and computer interpretation (to discern variations from the normal). Finally, the early recognition of alterations in ventilation in a large screened population may assist in the early diagnosis of disordered regional pulmonary function as has been seen in bronchogenic carcinoma and pulmonary emphysema. (auth)

29806 AMYLOID LESIONS OF BONE. Weinfeld, Albert; Stern, Martin H.; Marx, Lennart H. (Univ. of Miami, Fla.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 799-805 (Apr 1970).

Amyloid lesions of bone are rare, but should be considered in the differential diagnosis of skeletal abnormalities in a patient with generalized systemic disease. Two forms of bone lesions are discussed. The more common form seen radiologically has been the involvement of multiple major joints and their paraarticular structures by masses of amyloid. These joints can exhibit only soft tissue swelling, but the masses of amyloid may invade the underlying bone, producing multiple small erosions. These have been most often in the hips, shoulders, and elbows. The second form of amyloidosis of bone is caused by diffuse infiltration of the marrow. This may produce generalized demineralization of the skeleton, with collapse of vertebral bodies, resembling multiple myeloma and other diffuse skeletal diseases. This second form may, on the other hand, cause localized areas of bone destruction, as in our case. Another feature of this bone marrow form, hitherto undescribed but present in this case report, is the appearance of avascular necrosis of the femoral head, caused by deposition of amyloid in and around the blood vessels of the bone marrow. (auth)

29807 EMPLOYMENT OF BAYES' THEOREM AND A SMALL COMPUTER IN RADIOLOGICAL DIFFERENTIAL DIAGNOSIS. di Pietrantonj, F. (Centro Oncologico, Ancona, Italy). Radiol. Med.; 55: 1100-7(Nov 1969). (In Italian).

Radiological differential diagnosis can be greatly facilitated by the employment of Bayes' theorem to suitable matrices on an electronic computer. The application of mathematical models to differential diagnosis involves rethinking of the concept of diagnosis and the methods by which the physician proceeds. The mathematical and logical bases on which the application of the theorem of Bayes is based are discussed and reviewed. (auth)

29808 UROGRAPHY AND RADIONEPHROGRAPHY IN THE EVALUATION OF UROLOGICAL COMPLICATIONS IN THE COURSE OF UTERO-OVARIAN CANCER. De Marzi, S. (Univ., Florence); Atzeni, G.; Viola, S.; Legnaioli, M. Radiol. Med.; 55: 1079-89(Nov 1969). (In Italian).

Urography and radionephrography with ^{131}I-labeled hippuran were compared in 43 female patients with operated and unoperated neoplasia of the genital area to determine the behavior of the radionephrogram as a possibly more sensitive indicator of involvement of the urinary pathways resulting from cancer or as postoperative sequelae. Fifty-one of eighty-six examinations were in agreement; in a high percentage of the remaining 35, urography had shown either no abnormality or changes without pathological significance whereas the radionephrogram presented traces of a pathological type. Other clinical tests had given a negative result. Radionephrograms may present evidence of abnormalities even where there is no other sign of a pathological condition affecting the urinary pathways. (auth)

29809 SUPERVOLTAGE ROENTGENOGRAPHY WITH A LINEAR ACCELERATOR. Asakawa, Hiroshi; Watabe, Nobuyuki (Miyagi Prefectural Adult Disease Center, Japan). Jap. J. Clin. Radiol.; 14: 491-7(Jun 1969). (In Japanese).

Supervoltage (6 MeV) roentgenography with the Mitsubishi medical linear accelerator was studied. As an X-ray unit, the focus is smaller than 2mm in diameter, and the electronic timer with high accuracy can be set from 0.1 sec to 1.0 sec. The exposure dose can be freely controlled by regulating its dose rate and its exposure time, and the dose rate can be changed from 20 R/min at a distance of 1 meter from the focus. The focus-skin distance and the projection can be freely selected. Sakura X-ray film RR for industrial use, or Fuji X-ray film 100 is suitable, and the metal sensitizing screen Kyokko GS is adequate. Exposure times from 0.2 to 0.4 second are sufficient, and roentgenograms thus obtained had excellent grain condition, enough detail reproduction, and good sharpness. Clinically, this supervoltage roentgenography is extremely advantageous for diagnosing lesions in and around air-containing tissues. Not only lesions in the frontal and maxillary sinuses, nasal cavity, epipharynx, larynx, hypopharynx, and around the trachea, but also lesions behind the heart shadow are clearly seen on supervoltage roentgenograms. (NSA of Japan)

29810 AN X-RAY DIAGNOSIS OF RETICULOPERITONITIS TRAUMATICA IN CATTLE. Nechvatal, M. (Univ. of Agriculture, Brno). Vet. Med. (Prague); 14: 575-80(Oct 1969). (In Czech).

Cattle were examined for Reticuloperitonitis traumatica in the supine position on a hydraulic table adjustable for this purpose. The examination is carried out by means of a four-valve x-ray generator. The placing of the x-ray tube and amplifier on separate posts and their interconnection to allow for an all-direction movement is described. Normal and pathological x-ray records of reticulum and adjacent areas are described. In 80 cows the x-ray reticular findings are compared with those obtained during rumenotomy. In 73 animals (91.2%) the findings were the same (57 positive and 16 negative). In seven cows (8.8%) the findings varied. Ruminotomy-uncontrolled cows were examined (66 in number) and 41 negative and 25 positive findings were obtained. Of the total number of 146 animals, 83 (56.8%) were x-ray positive, 61 (43.8%) were negative, and 2 (1.4%) were dubious. (auth)

29811 EVALUATION OF HEPATIC REGENERATION BY SCINTILLATION SCANNING, CHOLANGIOGRAPHY, AND ANGIOGRAPHY IN MAN. Aronsen, K. F.; Ericsson, B.; Nosslin, B.; Nylander, G.; Pihl, B.; Waldeskog, B. (Malmoe General Hospital, Sweden). Ann. Surg.; 171: 567-74(Apr 1970).

Postoperative scintigraphic cholangiographic, portographic, and arteriographic follow-up examinations were performed in seven patients who had been subjected to hepatic resections of varying size. The liver remnant was found to increase rapidly in size during the immediate post-operative period. In one instance a slow increase could be seen for two years. The investigation showed the portal and arterial vasculature, the bile ducts, and the parenchymal and reticulo-endothelial cell mass to grow concomitantly during the regeneration period. (auth)

29812 DISTRIBUTION OF RADIOACTIVITY IN THE BODY FOLLOWING THERAPEUTIC APPLICATION OF RADIOACTIVE IODINE ^{131}I IN PATIENTS WITH THYROID GLAND CARCINOMA. Nemec, J.; Vohnout, S.; Vana, S. Vnitr. Lek.; 14: 1169-75 (1968). (In Czech).

The distribution of ^{131}I following therapeutic application was checked by scanning. This revealed, in a number of cases, accumulation of activity in secondary deposits of differentiated thyroid gland cancer which, according to tracer dose pattern, were considered to be functionally inactive metastases. This early functional differentiation of metastatic deposits may be caused by minimal basal accumulation in hormonally suppressed tissue; frequently, however, this might reflect alterations of TSH secretion accompanying radioiodine therapy. Scanning studies of the distribution of radioactivity for the demonstration of metastatic deposits appears useful during the course of radioiodine therapy. (Excerpta Med.)

29813 SAMARIUM FILTERS FOR DENTAL RADIOGRAPHY. Richards, Albert G.; Barbor, Gerald L.; Bader, James D.; Hale, James D. (Univ. of Michigan, Ann Arbor). Oral Surg., Oral Med., Oral Pathol.; 29: 704-15(May 1970).

The spectral sensitivity of a widely used dental x-ray film was found to be at a maximum for photons in the 35 to 55 keV range. Theoretical considerations indicated that photons in the 37.5 to 40 keV range are best suited for dental radiography. Radiographs made with monoenergetic beams confirmed the theoretical conclusions. A sheet of 0.2 mm thick samarium preferentially filtered the x-ray beam generated with 70 kVp so that most of the transmitted photons had energies in the 30 to 50 keV range. With this filter, the exposure time must be increased 2.25 times over that used with a 2 mm aluminum filter, but its use reduced the skin exposure by about one-third, the integral absorbed dose by 14%, and the gonadal exposure by a lesser amount. The contrast displayed in radiographs made with the samarium filter was slightly better than that produced with conventional aluminum filters. The use of the samarium filter with 90 kVp radiation further reduced skin exposure and integral dose. However, these reductions were achieved at the expense of image quality. (auth)

29814 MYOCARDIAL SCINTISCANS. Ballaira, L. (Univ., Turin). Minerva Radiol.; 14: 488-93(Nov 1969). (In Italian).

Selection of a suitable tracer for employment in the scintigraphic diagnosis of myocardial infarct is discussed and leads

to the conclusion that the hot and cold zone methods offer both advantages and disadvantages. The most successful reports seem to indicate the superiority of ^{131}Cs for cold and ^{203}Hg for hot zone visualization. (auth)

29815 USE OF TECHNETIUM IN THYROID SCANNING. Crema, G. L.; Bagni, B.; Biolcati, A. R. (St. Anna Hospital, Ferrara, Italy). Minerva Radiol.; 14: 484-7(Nov 1969). (In Italian).

The advantages inherent in the use of ^{99m}Tc in thyroid scanning instead of iodine isotopes are explained and attention is drawn to the excellence of the pictures obtained. (auth)

29816 BLOOD FLOW MEASUREMENT THROUGH SINGLE CORONARY ARTERIES BY ROENTGEN DENSITOMETRY. PART II. RIGHT CORONARY ARTERY FLOW IN CONSCIOUS MAN. Rutishauser, Wilhelm; Noseda, Giorgio; Bussmann, Wulf-Dirk; Preter, Bruno (Univ., Zurich). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 21-4(May 1970).

Since roentgendensitometric coronary flow measurement has shown no systematic deviation from simultaneous electromagnetic flow values in dogs, the flow through the right coronary artery was measured in man with this new principle. Only patients with normal appearance of the right coronary artery were included. The mean flow in 13 patients with a mean body surface area of 1.73 ± 0.07 (±1 SE) m^2 amounted to 86.7 ± 9.1 ml/min. This value is consistent with the results of the washout methods which only yield flow per unit of tissue of one assumes that the right coronary artery perfuses normally somewhat more than ⅓ of the myocardial mass. (auth)

29817 ROENTGENOGRAPHIC DIAGNOSIS OF PACEMAKER FAILURE. McHenry, Malcolm M.; Grayson, Charles E. (Sutter Memorial Hospital, Sacramento, Calif.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 94-100(May 1970).

The importance of roentgenographic studies in identifying pacemaker malfunction is discussed. Conventional roentgenograms and fluoroscopy can substantially aid the surgeon in identifying the cause of a pacing failure. Roentgenographic examination of the batteries may occasionally aid in determining the ideal time for replacement. Roentgenographic evaluation of the patient with a permanent transvenous pacemaker should be done before he leaves the radiology department to ensure that optimum catheter position has been attained. (auth)

29818 ANGIOCARDIOGRAPHIC AND ANATOMIC FINDINGS IN ORIGIN OF BOTH GREAT ARTERIES FROM THE RIGHT VENTRICLE. Hallermann, Franz J.; Kincaid, Owings W.; Ritter, Donald G.; Ongley, Patrick A.; Titus, Jack L. (Mayo Clinic, Rochester, Minn. Mayo Foundation, Rochester, Minn.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 51-66 (May 1970).

The diagnosis of origin of both great arteries from the morphologic right ventricle requires angiocardiographic demonstration that the pulmonary artery and aorta arise from the same ventricle and the anatomic features of the ventricle are those of right ventricular myocardium, and fibrous continuity between the morphologic mitral valve and either semilunar (aortic or pulmonic) valve is absent. The inter-relationship of the great arteries at the level of the semilunar valves varies. The basic anomaly may exist with a normally positioned heart, dextrocardia, ventricular inversion, or common (single) ventricle. Pulmonic stenosis is common and usually is present when isolated dextrocardia exists. Subaortic stenosis may be present. Other cardiovascular malformations also may occur, including abnormalities of the atrioventricular valves, patent ductus arteriosus, right aortic arch, isolation of the left subclavian artery, hypoplastic left ventricle, peripheral pulmonary artery stenosis, coarctation of the aorta, and left superior vena cava. (auth)

29819 BLOOD FLOW MEASUREMENT THROUGH SINGLE CORONARY ARTERIES BY ROENTGEN DENSITOMETRY. PART I. A COMPARISON OF FLOW MEASURED BY A RADIOLOGIC TECHNIQUE APPLICABLE IN THE INTACT ORGANISM AND BY ELECTROMAGNETIC FLOWMETER. Rutishauser, Wilhelm; Bussmann, Wulf-Dirk; Noseda, Giorgio; Meier, Willy; Wellauer, Josef (Univ., Zurich). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 12-20(May 1970).

The blood flow through the anterior descending branch of the left coronary artery in four anesthetized open-chest dogs was calculated on the basis of a new roentgen cinedensitometric technique and compared with the flow as measured simultaneously by an electromagnetic flowmeter. The densitometric flow calculation was based on the principle that the quotient of the volume of an arterial segment and the mean circulation time necessary to traverse this segment are equal to the volume flow. Injections of contrast medium were made while respiration was stopped and the heart was paced from the right atrium. There was no systematic deviation between the densitometric and the mean electromagnetic flow measurement during the passage of the contrast bolus; the correlation coefficient between simultaneous measurements was 0.932. The injection of the contrast medium caused an oscillation in flow but small doses caused no significant change compared with the preinjection value. Coronary angiocardiography thus may be used for flow measurement through single coronary arteries in intact conscious man. (auth)

Radiotherapy

Refer also to abstracts 29698, 29821, 29878, 29884, 29885, 29887, 29890, and 29891.

29820 (DMRE-69-3, pp 147-52) RECORDS-KEEPING IN A RADIOTHERAPY CENTER. Collins, Vincent P. (Rosewood General Hospital, Houston, Tex. Radiotherapy Center).

Record keeping in a radiotherapy department comprehensively documents the administration of radiation and the effect produced. This is the application of the concept of dose, that if the administration of the agent is carefully planned, and meticulously executed, then a desired effect previously demonstrated can be predicted and duplicated. To the degree that radiation is less certainly controlled, that the timing and distribution are unknown, and that the effect is not specific or could have resulted from other causes, the relation between cause and effect dissolved and dose is not an applicable term. Information to be included in records of radiotherapy includes: history and examination; consent to treatment; the treatment plan; localization and verification films; the treatment record; progress notes; and the illustrations. (C.O.)

29821 (UCRL-18793, pp 135-9) HEAVY-PARTICLE THERAPY IN CUSHING'S DISEASE: A PROGRESS REPORT. Linfoot, John A.; Manougian, Edward; Snyder, Norton J.; Carlson, Richard A.; Chong, Claude Y.; Born, James L.; Tobias, Cornelius A.; Lawrence, John H. (California Univ., Berkeley. Lawrence Radiation Lab.).

Heavy particles were used to treat 12 patients with Cushing's disease for control of adrenal hypersecretion. Summarized steroid data for all patients are presented in tabular form. It was concluded that larger doses of radiation are required for treating Cushing's disease than for the satisfactory control of acromegaly. (C.O.)

29822 IRRADIATION OF BONE TUMORS IN DOGS. Hartung, K.; Clauss, W. (Freie Univ., Berlin). Kleintier-Prax.; 14: 4p(1969). (In German).

The effectiveness of x radiation for therapy of bone tumors in dogs is discussed and compared to other tumors. With currently employed techniques, the result for osteosarcomas is more palliative than curative. In carcinomas of the jaw, the effectiveness of x radiation is more favorable. It is suggested, however, that, even in cases of planned surgical procedures, radiation treatment be given if facilities are available. (tr auth)

29823 EFFECT OF DURATION OF BREATHING 95 PERCENT OXYGEN PLUS 5 PERCENT CARBON DIOXIDE BEFORE X-IRRADIATION ON CURE OF C3H MAMMARY TUMOR. Inch, W. Rodger; McCredie, John A.; Sutherland, Robert M. (London Clinic, Ont. Univ. of Western Ontario, London). Cancer; 25: 926-31(Apr 1970).

Inhalation of 95% oxygen plus 5% carbon dioxide at atmospheric pressure one-half minute before and during x ray therapy increased the rate of cure of the syngeneic mammary tumor in C3H mice. The effect was less when the mice were allowed to breathe the gas for 12 minutes before treatment. When 100% oxygen, at one atmosphere, was breathed before irradiation for one-half minute or 12 minutes, or at 4 atmospheres for 5 minutes, the rate of tumor cure was increased compared with breathing air at atmospheric pressure. There was no difference between inhaling normobaric 100% oxygen for one-half minute or 12 minutes, 95% oxygen plus 5% carbon dioxide for 12 minutes, or hyperbaric oxygen. Loss of weight and mortality were greater in mice which inhaled hyperbaric oxygen. (auth)

29824 AFTERLOADING MULTIPLE IRRADIATORS FOR THE TREATMENT OF CANCER OF THE CORPUS OF THE UTERUS: A PRELIMINARY REPORT OF A NEW DEVICE. Simon, Norman (City Univ., New York). J. Mt. Sinai Hosp., N. Y.; 36: 443-5(Sep-Oct 1969).

A newly described afterloading method for packing the uterine cavity with multiple irradiators in the presence of adenocarcinoma of the fundus appears to be practical and promising. Each irradiator is a plastic capsule with a hollow thin tube connecting its cavity to the outside. After the capsules have been packed into

the uterine cavity, small sized sources of high activity radioactive material are loaded into the devices. Accuracy is increased, radiation exposure to operating room personnel is nil, and exposure to the radiotherapist and other hospital personnel is sharply reduced. (auth)

29825 DIRECT EXPOSURE IRRADIATION. Mikuriya, Shuichi (National Cancer Center, Tokyo). Gan No Rinsho, Suppl.; 107-112(Nov 1969). (In Japanese).

Clinical experiences with the direct-view irradiation by betatron for carcinomas of the urinary bladder, pancreas, and meninges are reported. Deep-seated tumors are a possible indication for the external irradiation of high-energy electron beam providing they are surgically open for exposed to direct irradiation. Twenty-eight patients with transitional-cell carcinoma of the urinary bladder were given a single dose of 2,500 to 3,000 R of 4 to 6 MeV in 4 to 5 cm in direct-view irradiation, followed by 3,000 to 4,000 R external irradiation, with a survival period ranging from 3 months to 4 years. In two cases of pancreatic carcinoma, tumor dose was 2,500 R of 17.5 MeV in one case and 12 MeV in the other, with supplementary external irradiation of 4,200 R and 2,200 R, respectively. A patient with recurrent meningioma was given preoperative radiotherapy with 1,000 R of 6 MeV by linear accelerator, followed by betatron irradiation with a single dose of 2,000 R of 6 MeV, 6 cm in direct-view irradiation, and further treatment with 3,000 R of supervoltage x ray, showing no sign of recurrence. The combined use of electron beam and supervoltage x ray proved to be effective with minimum radiation injury. No serious radionecrosis was observed in spite of mass irradiation. (NSA of Japan)

29826 RADIUM VS ^{137}Cs IN THE TREATMENT OF SKIN CANCER: A COMPARATIVE STUDY OF THEIR DOSE RATES AND EFFECTS. Wooldridge, W. E.; Lorenc, E. (Univ. of Oklahoma, Oklahoma City). S. Med. J.; 62: 563-6(1969).

Experimental data are presented that indicate that the dose rate of ^{137}Cs is only slightly less than that of radium up to distances of 15 cm from the source when measured in air, water, plastic, and small thicknesses of lead. It is concluded that this offers only a modest advantage in protection. Cesium-137 requires less shielding for storage than radium. Evidence is quoted that radium needles of modern construction are quite safe with proper handling and that the possibility of rupture from a buildup of internal pressure is negligible. Small scale comparative studies of radium and equivalent amounts of ^{137}Cs implanted into the subcutaneous tissues of rabbits support the conclusions of physical data that both these radiations can be used satisfactorily in the treatment of skin cancer. (Excerpta Med.)

29827 FRONTIERS OF RADIATION THERAPY AND ONCOLOGY. VOLUME 3. THE RELATIONSHIP OF TIME AND DOSE IN THE RADIATION THERAPY OF CANCER. Proceedings of the Third Annual San Francisco Cancer Symposium. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968. 256p. sFr.; DM 69.--; $16.55; 138s. (CONF-671075-(Vol. 3)).

Separate abstracts were prepared for each of the 21 papers of the symposium for inclusion in NSA. (C.O.)

For abstracts of individual papers see: 29828–29842, 29878–29882, and 29897.

29828 HISTORICAL CHANGES IN TIME–DOSE RELATIONSHIP IN THERAPEUTIC RADIOLOGY. Del Regato, J. A. (Penrose Cancer Hospital, Colorado Springs, Colo.). pp 1-5 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

The development of the answers to the questions: what should be the amount of radiation given; and what should be the optimum time for the administration of the chosen dose is discussed. It is noted that there is no clear-cut stepwise development of the concepts, indeed an overlap of methods without chronology is found by the historian. The four successively advocated methods of intensive dosage, repeated short courses, multiple subdivided doses, and the protracted fractional method are each discussed briefly. (17 References) (C.O.)

29829 RATIONALE OF DOSE FRACTIONATION. Fowler, J. F. (Hammersmith Hospital, London). pp 6-23 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

The questions we need to answer to be able to suggest rational radiotherapy are becoming clearer; we need to know the extent to which various tumor and normal tissues change in sensitivity at different times after single doses of various size, (the changes being due to hypoxic shifts, synchrony, repopulation, or all three). Then we need to know the same information after several doses. If we knew that, we should know almost everything we needed. These factors could of course be estimated fundamentally by finding the proportion of cells dividing, the proportion hypoxic, their distribution of cell cycle times, and by finding how these change after irradiation. (This includes the cell populations responsible for capillary renewal too.) This will be a long, slow process, and methods of application to individual patients must be considered. The changes in sensitivity with time can also be estimated—less precisely but more reliably—by "functional" tests such as cure of tumors, or failure of function of normal tissue, which should guide the more fundamental measurements and save them from an experimental network of too many variables to investigate. The most relevant radiobiological data could come from radiotherapeutic results themselves, by careful clinical assessment and recording of rates of change of normal tissue reaction or tumor size. (auth)

29830 THE REVERSE STRANDQVIST EFFECT. A CONCEPT OF SUPEREFFECTIVE FRACTIONATION OR WASTED IRRADIATION. Rubin, P.; Casarett, G. W. (Univ. of Rochester, N. Y.). pp 24-35 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

The Strandqvist isoeffect line may be a trap to future investigative work if we assume this to be a radiobiologic law. Our view is that a single dose which would be lethal to a tumor (LD 100/90 days) is an inefficient way of administering irradiation, rather than being the most efficient. A single dose, to be effective in destroying a radioresponsive squamous cell cancer, must be lethal to oxygenated and hypoxic cells in the tumor, both for proliferating and non-proliferating cells, and must depend on the indirect effects mediated by the vasculature. If all cells were fully oxygenated and proliferating synchronously at one moment in time, the single effective dose would be reduced by at least a factor of 10 or, in some instances, a factor as large as 100. A search for a fractionated dose schedule to the same or a lesser total dose level that is more effective than the single dose is a fertile area for future experiments. The waste in fractional doses is due not only to recovery but to the use of excessive amounts of irradiation to destroy the radioresistant fraction of a tumor. It is apparent that the ideal dose, the ideal time, the ideal fractionation, the ideal protraction are still beyond the reach of the radiotherapist. Three mechanisms through which efficient fractionation might be achieved have been explored. The biological observation in five different systems that the net effect of a given dose delivered in two or more fractions is greater than a similar undivided dose occurred using widely variable time-dose schedules. This suggests that there may be different time-dose schedules that will favor different tumors in addition to differences between normal tissues and neoplasma that could lead to more favorable therapeutic ratios. Not all mechanisms will apply in any one circumstance, but their exploitation revives the potential goal of a truly selective effect in radiotherapy. (auth)

29831 DOSE–RESPONSE AT EACH FRACTION IN A RADIOTHERAPY SERIES. Du Sault, Lucille A. (Henry Ford Hospital, Detroit). pp 36-45 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

A combination of size of fractions and intervals between fractions has been found for which the total dose required for a given cure rate of mammary adenocarcinomas in C3H mice is determined by the number of fractions into which the dose is broken. Evidence has been presented that implies reoxygenation of tumor cells during the radiotherapy series. It has been shown that the fractionation effect is the same for mouse tumor cure and for pig's skin reaction, which suggests that it may be much the same for many mammalian tissues. Implications of these data for clinical radiotherapy and the therapeutic ratio have been discussed. (auth)

29832 TIME, FRACTIONATION, AND DOSE RATE IN RADIOTHERAPY. Ellis, F. (Churchill Hospital, Oxford). pp 131-40 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

Methods used in the extraction of relevant information on studies pertaining to the relation of dose to cell survival for various animal cells and about skin reaction to dose, time, and fractionation are discussed. Clinical results were used to separate and fractionate time effects and criticisms were leveled at the assumptions that were necessary. The use of combined radium and external radiation was compared to adding apples and oranges. It was suggested that a computer program be devised for data retrieval and analysis; the summary record sheet required for implementation of the program is described and discussed. (C.O.)

29833 FRACTIONATION IN CLINICAL HYPERBARIC RADIATION THERAPY. Wootton, P. (Univ. of Washington, Seattle). pp 141-51 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

Results of hyperbaric radiotherapy are reviewed and evaluated with respect to a mathematical model that is based on the two component energies of the radiations employed. The model is adopted to both the in vivo situation and the normal oxygen situation. Findings indicated that in devising an index of the predicted efficacy of any fractionation regime, it is not sufficient to state the equivalent single dose or equivalent dose at any other number of fractions but that some statement on the ratio of the effect in tumor and that in normal tissues be included. The model outlined suggested that if the fractions are delivered in oxygen, that these ratios will be affected by the number of fractions, increment size, increment spacing, and volume of tissue irradiated as well as by the type of radiation employed. (C.O.)

29834 TOTAL BODY IRRADIATION WITH FRACTIONATED DOSAGE SCHEDULES. Johnson, R. E. (National Cancer Inst., Bethesda, Md.). pp 152-62 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

The importance of the time-dose relationship in the clinical use of total body irradiation is discussed. Fractionation has markedly attenuated the normal tissue toxicity seen with single, high-dose exposures without a corresponding loss of the therapeutic effect. In general, toxicity from fractionation schedules of the type described has not been clinically detectable except for the hematopoietic system. The possibility of bone marrow depression requires careful observation of peripheral blood counts and modification of treatment as indicated. In general, there is no evidence that suppressive therapy alters the basic disease in the lymphoproliferative disorders discussed in this paper. It therefore seems reasonable to assume that more complete eradication of disease must be achieved if life expectancy is to be increased. And in order to more optimally exploit the potential of total-body irradiation, the ever important time-dose relationship will require continued investigation. (auth)

29835 ADVANTAGES AND DISADVANTAGES OF INTENSIVE SPLIT-DOSE RADIATION THERAPY. Levitt, S. H.; Bogardus, C. R. Jr. (Medical Coll. of Virginia, Richmond. Univ. of Oklahoma Medical Center, Oklahoma City). pp 163-72 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

The advantages of the split-dose intensive therapy when compared to routine fractionated therapy are: similar survival, similar symptomatic relief, no apparent severe complications, less financial burden on the patient and family, less separation of the patient and family, increase in capacity of treatment center, biological determination, i.e., patients who will not be able to complete the course do not spend a great deal of time under treatment because of advanced disease, etc. The disadvantages are: apparent increase in normal tissue damage which does not appear to be incapacitating, and apparent lesser tumor response. In view of this similar symptomatic and survival effect and the definite superiority from a socio-economic status, it is proposed that split dose intensive therapy is a more reasonable approach to symptomatic relief of patients with advanced lung cancer than fractionated radiotherapy. Further careful clinical trials utilizing different time dose sequence to increase the tumor response and decrease normal tissue reaction appear to be justified and worthwhile. (auth)

29836 TIME-DOSE RELATIONSHIPS IN INTERSTITIAL THERAPY. Wizenberg, M. J. (Univ. of Maryland, Baltimore). pp 173-9 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

Applications of radioisotope sources for interstitial therapy of neoplasms are discussed. Data on the type of radiation emitted and half-life of ^{198}Au, ^{51}Cr, ^{131}Cs, ^{125}I, ^{192}Ir, and ^{222}Rn are summarized. A formula is presented for use in the calculation of the radiation dose as a function of implant time. Other methods used for the dosimetry of interstitial radiation sources are reviewed. (C.H.)

29837 FURTHER EXPERIENCE WITH SPLIT-COURSE RADIATION THERAPY. Sambrook, D. K. (Singleton Hospital, Swansea, Wales). pp 180-94 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

The split-course method of radiotherapy is examined from three points of view: an assessment of the value of the method in the light of practical experience and results obtained; consideration of different methods of fractionation within the general framework of the method; and a discussion of possible dangers and pitfalls that may be associated with the method. The data are presented in tabular form and briefly discussed. Tumor cell repopulation during the rest interval (time between doses) is also discussed. (C.O.)

29838 SPLIT-DOSE RADIOTHERAPY FOR HEAD AND NECK CANCER. Scanlon, P. W. (Mayo Clinic and Foundation, Rochester, Minn.). pp 195-211 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

The effect of split-dose radiotherapy methods on radiocurable lesions, particularly early cancer of the head and neck, was investigated. Cancer of nasopharynx, tongue, tonsil, and larynx were treated. In none of the four reported series did the split-dose method prove inferior to conventional continuous radiotherapy. Results are presented in tabular form. (C.O.)

29839 NINE YEARS EXPERIENCE WITH REDUCED FRACTIONATION. Botstein, Ch.; Dalinka, M. K. (Montefiore Hospital, Bronx, N. Y.). pp 212-19 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

Nine years of experience with reduced fractionation using ^{60}Co γ radiation have shown the following advantages: better general tolerance by the patient, convenience to the patient through reduction of weekly visits, convenience to the department by granting more time for follow-up, economic gain for the patient and the department, and a better initial tumor response as well as a more rapid reduction of symptoms. Particular emphasis is given to the discussion on tumor response. (C.O.)

29840 RADIOBIOLOGICAL BASIS AND EARLY CLINICAL EXPERIENCE OF A CONCENTRATED SPLIT COURSE. Schlienger, M.; Dutreix, J. (Institut Gustave Roussy, Villejuif, France). pp 220-8 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

A particular type of split-course irradiation is described, composed of 2 sessions of 850 rads delivered at a 48 hr interval (first series) followed by a period of 20 days of rest, then by the second part of the irradiation delivered with a usual fractionation (second series) 2700 rads/9 sessions/3 weeks. The overall duration of the treatment is the same (6 weeks) as with the usual technique. The theoretical radiobiological basis and the early results of the treat-

ment of 120 patients treated with x rays alone are given. The first series was used as preoperative irradiation in 20 cases (cancer of the bladder, of the lung and of the kidney). If no serious disorder or adverse reaction or surgical difficulties could be attributed to the peculiar fractionation it is too early to assess the results in the matter of cure and late complications. The early results of a randomized study dealing with tonsillar epithelioma show a faster disappearance of gross tumor with the modified irradiation than with the usual planning. The justification for this technique is discussed according to radiobiological and clinical data. In terms of their experience, the authors feel they can recommend such kind of irradiation for palliative treatment or prior to biopsy or for preoperative irradiation. However, the size of the dose is still open to further discussion. (auth)

29841 NEVER ON SUNDAY, SATURDAY, OR WEDNESDAY. Green, J. P.; Vaeth, J. M.; Lowy, R. O. (Claire Zellerbach Saroni Memorial Tumor Inst., San Francisco. Mount Zion Hospital and Medical Center, San Francisco). pp 229-37 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

The Zellerbach Saroni Tumor Institute at Mount Zion Hospital and Medical Center has, for two and a half years, followed a four-times-a-week treatment schedule. This schedule has brought about increased patient care and improved resident training, without observable increase in normal tissue reactions. Based on radiobiologic observations, there may be increased tumor radiation response on such a fractionation schedule. A clinical study is described in which 21 patients were irradiated to identical doses but on a four-times versus five-times weekly schedule to bilateral internal mammary fields. No significant difference in skin reactions between the two groups was clinically observed. At the time of editing, 3 cases have been followed for one year, 15 cases for six months and all patients for three months. (auth)

29842 FRACTIONATION IN RADIATION THERAPY OF CARCINOMA OF THE UTERINE CERVIX: RESULTS OF PROSPECTIVE STUDY OF 3 VS. 5 FRACTIONS PER WEEK. Marcial, V. A.; Bosch, A. (Puerto Rico Nuclear Center, San Juan. I. Gonzales Martinez Oncologic Hospital, San Juan, Puerto Rico. Univ. of Puerto Rico, San Juan). pp 238-49 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol.3).

A random prospective study of fractionation of external irradiation of 200 cases of carcinoma of the cervix with a minimal follow-up period of two years has been presented. Both the test cases and the controls received the same weekly and total doses of external irradiation and this was followed by a standard curietherapy application, which had produced satisfactory five years results. The only difference in the two groups was that the test cases received their irradiation in three-fractions-per-week versus five-fractions-per-week in the controls. The preliminary results of this study suggest a more favorable situation regarding completeness of treatment and survival, when the stated weekly dose is delivered in three-fractions versus the conventional fractionation; this is more notable in the advanced cases. The complication rate and distant metastases were not significantly different in the two groups. (auth)

Radiation Effects on Animals

Refer also to abstracts 29708, 29710, 29711, 29731, and 29736.

29843 (UCRL-18793, pp 38-42) DISTRIBUTION OF SPLEEN COLONY FORMING UNITS IN BONE AND MARROW. Van Dyke, Donald C. (California Univ., Berkeley. Lawrence Radiation Lab.).

Spleen colony-forming cells were found in bones of mice. An assay technique using γ-radiosensitivity was used. The total number is small, but the ratio of CFU to nucleated cells is greater than in marrow. The results would seem to indicate that bone either collects or generates marrow colony-forming cells. (C.O.)

29844 (UCRL-18793, pp 100-4) A METHOD TO DETERMINE THE ACUTE RADIATION RESPONSE OF HUMAN CELLS TO π MESONS. Burki, H. John; Barendsen, Gerrit W.; Raju, Mudundi R.; Amer, Nabil M.; Curtis, Stanley B. (California Univ., Berkeley. Lawrence Radiation Lab.).

Human cells in culture were exposed to γ radiation in the frozen state in liquid nitrogen. The survival curve did not change, although the dose rate varied from 0.89 rad/min to 52.1 rads/min. Since, under these conditions, the effects of dose rate were eliminated, one may simulate the effects of a π-meson beam acute exposure, using the beam currently available that has a dose rate of 30 rads/hr. One preliminary experiment indicated a pion RBE of 1.6. Improved experiments of this type may allow determination of the complete parameters of the acute exposure survival curve of human cells after π-meson exposure. (auth)

29845 (UCRL-18793, pp 105-12) THE RBE OF NEGATIVE PIONS IN 2-DAY-OLD ASCITES TUMORS. Feola, Jose M.; Raju, Mudundi R.; Richman, Chaim; Lawrence, John H. (California Univ., Berkeley. Lawrence Radiation Lab.).

A two-day-old lymphoma was used in order to obtain information on the survival of a well-oxygenated tumor. Partial pressure of oxygen (p_{O_2}) was measured with a microelectrode; the 5-day-old tumors were hypoxic, and the 2-day-old tumors well-oxygenated. Only one mouse at a time could be irradiated at a dose rate of 30 rads/hour. Doses ranged from 60 to 150 rads. After irradiation, mice were sacrificed, cells withdrawn, counted, and serial dilutions prepared from each irradiated mouse and from nonirradiated controls. Each concentration was injected intraperitoneally into a group of 10 female LAF_1 mice; at the end of 8 weeks the TD_{50} (the number of tumor cells needed to produce 50% takes) for each group was evaluated. The ratios of the TD_{50} for the control group to the TD_{50}'s of each irradiated group gave the surviving fractions, with which the survival curve was drawn. A curve with a small shoulder was obtained: $D_0 = 76$ rads, and $D_Q = 44$ rads. Two replicate experiments were done with ^{60}Co γ rays (150 rads/hr). The 0.1 level of survival was used to estimate the RBE, which was found to be 5.4 ± 0.6, in good agreement with the previous results. (C.O.)

Invertebrates

Refer also to abstract 29906.

29846 TRYPANOSOMA CRUZI: EFFECTS OF GAMMA RADIATION ON GROWTH AND INFECTIVITY. Martinez-Silva, R.; Lopez, V. A.; Colon, J. I.; Chiriboga, J. (Puerto Rico Nuclear Center, San Juan). Contract AT(40-1)-1833. Exp. Parasitol.; 25: 162-70(Aug 1969).

The effects of γ radiation on Trypanosoma cruzi were studied using morphology, motility, multiplication, and infectivity as parameters of investigation. Motility of the parasites was not abolished by dosages that rendered cultures sterile. Morphologic alterations were detectable with doses of 50,000 rads. The inactivation rate of growth and infectivity, both in mice and in tissue culture, was exponential with a D_{37} of 4000 rads. Similar radiosensitivity was observed for three strains of T. cruzi that were derived from tissue culture and in vitro media; moreover, parasites previously subjected to radiation showed radiosensitivity similar to the controls. (auth)

29847 ELECTRON MICROSCOPE STUDY ON THE ACTION OF IONIZING RADIATION ON THE TESTIS OF GRYLLUS ARGENTINUS. Wettstein, Rodolfo; Sotelo, J. Roberto (Instituto de Investigacion de Ciencias Biologicas, Montevideo). Arch. Soc. Biol. Montevideo; 27: Special No., 140-5(1969).

Crickets, Gryllus argentinus, were exposed to 1000 R ^{60}Co γ radiation. During exposure, they were placed in special lead containers that shielded the head and tail ends of the animal. Thus, radiation included only the fourth, fifth, and sixth abdominal segments containing the testes. After exposure, the testes were sectioned under an electron microscope. Several days after irradiation, intense degenerative changes were found in the spermatogonia. Spermatocytes showed changes in the nuclear membrane. Spermatids showed an invagination of the nuclear membrane and an hourglass strangulation of the nucleus. (H.B.G.)

29848 MOSAIC ANALYSIS OF BRISTLE DISPLACEMENT IN DROSOPHILA. Claxton, J. H. (Univ. of California, Berkeley). Genetics; 63: 883-96(Dec 1969).

Comparisons of achaete and non-achaete female Drosophila melanogaster revealed that the anterior dorsocentral bristles are relatively further ahead of the scutellar groove in the mutants. This modification (displacement) of bristles was examined in achaete mosaics, produced by x-ray induction of somatic crossing over in heterozygous achaete female larvae. With respect to displacement of the anterior dorsocentrals, the behavior of achaete tissue patches in mosaics is basically autonomous. Several possible explanations for this result are discussed in terms of the concepts of prepattern and competence. (auth)

Vertebrates

Refer also to abstracts 29668, 29713, 29715, 29716, 29732, 29734, 29781, 29784, 29785, and 29831.

29849 (AD-700235) PLASMA CHEMISTRY VALUES FOR THE MONKEY (MACACA MULATTA) AFTER A SUPRALETHAL DOSE OF PULSED MIXED GAMMA-NEUTRON RADIATIONS. Turbyfill, C. L. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Dec 1969. 22p. (AFRRI-SR-69-23). CFSTI.

Monkeys (Macaca mulatta) were given a 4-krad midline tissue dose of pulsed mixed γ-neutron radiations. Chemical analyses of 11 different constituents of plasma were made before irradiation and at 1, 6, and 12 hours postirradiation to evaluate the extent of radiation injury as indicated by changes in the composition of the plasma. A significant increase in the plasma concentration of glutamic-oxalacetic transaminase, total lactic dehydrogenase, creatinine, creatine, and urea nitrogen was found postirradiation. Although some of the constituents of plasma that were found to increase after irradiation were probably from radiosensitive tissue, other tissues such as muscle, not considered radiosensitive, appear to have been also injured when subjected to this dose of radiation. (auth)

29850 (AD-700237) MINIATURE PIG PERFORMANCE AFTER FRACTIONATED DOSES OF IONIZING RADIATION. Chaput, R. L.; Kovacic, R. T. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Dec 1969. 25p. (AFRRI-SR-69-22). CFSTI.

Miniature pigs were trained to traverse on cue a two-chambered shuttlebox. The pigs received either unfractionated (6500, 8600, 11,600, or 13,00 rads) or fractionated (6800, 8500, 11,000, or 13,300 rads) doses of pulsed mixed γ-neutron radiation. The fractionated doses were delivered as two equal fractions 5 hours apart. Miniature pig performance after the second half of the fractionated dose was similar to or better than the performance observed after the first half of the dose. The pig's performance was markedly better when the dose was fractionated than when it was unfractionated; early transient incapacitation was shorter, and acceptable performance was achieved earlier and lasted longer. Also, mean survival times of the pigs that received fractionated doses were longer. Possible mechanisms that may be responsible for the reduced effectiveness of the fractionated doses are discussed. (auth)

29851 (AD-700742) ATTEMPT TO CLONE MARROW CELLS IN SPLEENS OF LETHALLY IRRADIATED RHESUS MONKEYS. Final Report, 1966-69. Eltringham, James R.; Casey, Harold W. (School of Aerospace Medicine, Brooks AFB, Tex.). Nov 1969. 14p. (SAM-TR-69-74). CFSTI.

An attempt was made to clone Rhesus marrow cells within the spleens of lethally irradiated Rhesus monkeys. Twelve animals received autologous transplants; two animals received allogeneic transplants; and four animals served as irradiation controls. Ten days following transplantation (or irradiation, in the case of the controls), the animals were sacrificed and their spleens removed. No macroscopic nodules were found in any of the spleens; microscopic examination of subserial sections revealed scattered erythrocytic clones in three of 14 animals that received transplants. Reticulocyte counts, peripheral leukocytes, and cellularity of marrow spaces indicated that the transplanted marrow had proliferated in 13 of the 14 animals with transplants. Under our conditions, significant marrow cloning did not occur in spleens of lethally irradiated Rhesus monkeys in a manner analogous to that described in similar studies with rodents. (auth) (USGRDR)

29852 (UCD-472-116) ANNUAL REPORT, FISCAL YEAR 1969. (California Univ., Davis. Radiobiology Lab.). Contract AT(04-3)-472. 136p. Dep. CFSTI.

Separate abstracts were prepared for 32 papers for inclusion in NSA. Other papers included a project introduction, experimental design summary, and studies on basic phenomena (no radiation involved). (C.O.)

For abstracts of individual papers see: 29620, 29695, 29708, 29725, 29731, 29732, 29740, 29747, 29780, 29784-29786, and 29853-29872.

29853 (UCD-472-116, pp 7-15) EFFECT OF EARLY FRACTIONATED WHOLE-BODY X-IRRADIATION ON THE OVARY. Andersen, A. C.; Simpson, Miriam E. (California Univ., Davis. Radiobiology Lab.).

A pilot study gives evidence that dogs can be sterilized by fractionated x ray exposures of 10 R (total 200 R) at 2 to 40 days of age. Unilateral ovariectomy at 7 months of age revealed the almost total absence of follicles. At puberty (12 to 14 months of age), 3 of the 15 irradiated beagles showed abortive signs of estrus but would not mate. Histologically the ovaries from such dogs contained bizarre-shaped follicles and luteinized bodies. Ovaries from those not exhibiting estrus were afollicular. Ovarian tumors were found in the irradiated dogs at 14.5 months of age. (auth)

29854 (UCD-472-116, pp 16-24) OVARY IN BEAGLES AT 7 TO 8 YR OF AGE FOLLOWING A SINGLE WHOLE-BODY X-RAY EXPOSURE PRIOR TO PUBERTY. Andersen, A. C.; Simpson, Miriam E. (California Univ., Davis. Radiobiology Lab.).

The ovaries from 10 control beagles and 6 beagles exposed at 7 to 9 months of age to 290 R x irradiation were examined 7 to 8 yr later. Ovaries from both groups were similar and were characterized by changes suggestive of senility: surface convolutions, abnormalities in subepithelial tubules, decrease in number of follicles, and microadenomas. (auth)

29855 (UCD-472-116, pp 25-7) COMPARATIVE OCULAR EFFECTS OF AGING AND X-IRRADIATION IN THE BEAGLE. Hosein, Amy A.; Magrane, W. G. (California Univ., Davis. Radiobiology Lab.).

An ophthalmologic survey of beagles in the x-irradiation colony was done in an effort to correlate gross ocular lesions with age and history of prior whole-body irradiation. None of the ocular lesions seen could be attributed to radiation-induced changes. That aging alterations were uniformly distributed among the experimental groups is possibly attributable to the life-shortening effects of x irradiation. (auth)

29856 (UCD-472-116, pp 28-32) EFFECT OF RADIOIODINE AND X-IRRADIATION ON BEAGLE PUPS. Fuller, J. M.; Bustad, L. K. (California Univ., Davis. Radiobiology Lab.).

Early results of a long-term study of the effects of ^{131}I and x irradiation on the thyroid are presented. Iodine-induced damage is indicated at dose levels as low as 4500 rads to the thyroid, as evidenced by decreased ^{131}I thyroidal uptake at 8 months post-exposure. A 4500-rad dose level was obtained by as little as 163 μCi ^{131}I. (auth)

29857 (UCD-472-116, pp 41-4) RADIOGRAPHIC CHANGES IN SKELETONS OF BEAGLES ADMINISTERED ^{90}Sr AND ^{226}Ra. Williams, R. Jean Romer; Hanson, R. J.; Goldman, Marvin; Rosenblatt, L. S. (California Univ., Davis. Radiobiology Lab.).

Radiographic injury scores for radionuclide-treated beagles are compared by dose, treatment, and time. Minimal radiographic injury seen on x rays of ^{90}Sr-treated dogs included osteosarcomas. Following ^{226}Ra injections, dose-time related changes are initially due to cortical thickening, fractures, and, finally, osteolytic lesions and tumors. Tumors appear to be equally distributed between axial and long bone sites. (auth)

29858 (UCD-472-116, pp 45-9) ^{90}Sr AND ^{226}Ra EFFECTS ON THE MUCOPOLYSACCHARIDES OF COSTAL CARTILAGE. Tsai, Huan-Chang; Nix, Nancy (California Univ., Davis. Radiobiology Lab.).

A linear decrease of mucopolysaccharide concentration in costal cartilage was found in control dogs 1 to 12 yr of age. Within 1 yr following ^{226}Ra treatment, a sharp reduction in mucopolysaccharides occurred, apparently related to the local dose rate. (auth)

29859 (UCD-472-116, pp 53-6) EFFECTS OF ^{226}Ra AND ^{90}Sr ON THE BEAGLE EYE. Hosein, Amy A.; Tsai, Huan-Chang (California Univ., Davis. Radiobiology Lab.).

Gross ophthalmologic examinations revealed a dose-time relation for uveal tissue alterations in ^{226}Ra exposed beagles. One case of a possibly ^{226}Ra induced malignant melanoma of the eye was observed. Ocular angiography and visual testing are being employed in the study of uveal alterations. Biochemical techniques are being utilized to study subtle changes in other ocular structures prior to the development of gross lesions. (auth)

29860 (UCD-472-116, pp 57-9) RADIONUCLIDE EFFECTS ON THE LENS PROTEIN OF THE BEAGLE. Tsai, Huan-Chang; Hosein, Amy A. (California Univ., Davis. Radiobiology Lab.).

Age-related changes were observed in the relative amount of water soluble and insoluble protein of the beagle lens in control dogs and those exposed to ^{90}Sr. The insoluble fraction increased linearly between 1 and 8 yr of age. There appeared to be an increase of insoluble protein in ^{226}Ra-treated dogs vs. controls. (auth)

29861 (UCD-472-116, pp 65-7) BONE MARROW AND PERIPHERAL BLOOD CELL VALUES IN YOUNG ADULT MALE BEAGLES. West, J. E.; Wilson, F. W. (California Univ., Davis. Radiobiology Lab.).

Bone marrow and peripheral blood values were obtained from repeated samplings of 12 healthy, young adult male beagles during the pre-exposure phase of a ^{60}Co gamma irradiation study. (auth)

29862 (UCD-472-116, pp 68-72) SOME DOSE RATE EFFECTS OF ^{60}Co GAMMA IRRADIATION ON THE HEMATOPOIETIC SYSTEM OF BEAGLES. West, J. E. (California Univ., Davis. Radiobiology Lab.).

Following acute or protracted (simulated solar flare) radiation,

hematopoietic injury and repair were measured in blood and bone marrow of beagles. The 30-min acute dose (240 R) appeared slightly more injurious than the 24-hr protracted dose (~11 R/hr) although recovery appeared more rapid after the acute dose. (auth)

29863 (UCD-472-116, pp 73-7) ERYTHROPOIETIC ALTERATIONS IN BEAGLES WITH ^{90}Sr INDUCED MYELOPROLIFERATIVE DISORDERS. Goldman, Marvin; Bulgin, Marie S. (California Univ., Davis. Radiobiology Lab.).

Red cell studies on normal dogs and those with ^{90}Sr-induced myeloproliferative disorders indicate that the anemias observed among the latter are related to defective erythropoiesis and accelerated erythrocyte destruction. The terminal states of anemia are due to cessation of erythropoiesis and intravascular destruction of endogenous and transfused red cells. (auth)

29864 (UCD-472-116, pp 78-84) RADIATION-INDUCED LETHALITY FROM ^{90}Sr AND ^{226}Ra ADMINISTRATION TO BEAGLES. Goldman, Marvin; Dungworth, D. L.; Bulgin, Marie S.; Rosenblatt, L. S.; Richards, W. P. C.; Bustad, L. K. (California Univ., Davis. Radiobiology Lab.).

When fed ^{90}Sr at 4 or more μCi/day for the first 1.5 yr of life some beagles die of myeloproliferative disorders that are present with anemia and may include myeloid metaplasia, myelofibrosis, and granulocytic leukemia. The incidence is dose-related and the earliest cases occur from 1 to 1.5 yr of age. Eight semimonthly radium injections between 1.2 and 1.5 yr of age cause a 50% cumulative probability of developing osteosarcoma to 4 to 4.5 yr of age following a total dose of 100 μCi and to 5 to 5.5 yr of age for one-third this dose. (auth)

29865 (UCD-472-116, pp 85-6) SERUM PROTEIN AND ISOENZYME STUDIES IN BEAGLES. Shifrine, M.; Galligan, S. Jean (California Univ., Davis. Radiobiology Lab.).

Association of a fast serum α_2-glycoprotein with ^{90}Sr-induced canine myeloproliferative disorders is suggested by starch electrophoresis patterns. The utility of lactic dehydrogenase isoenzymes activity in diagnosing the myeloproliferative syndrome is also being investigated. (auth)

29866 (UCD-472-116, pp 87-8) ATTEMPTS AT TRANSMISSION OF THE RADIATION-INDUCED CANINE MYELOPROLIFERATIVE SYNDROME TO DOGS AND MARMOSA MITIS. Shifrine, M.; Zee, Y. C.; Wolf, H. G. (California Univ., Davis. Radiobiology Lab.).

Cell-free preparations from dogs dying of radiation-induced myeloproliferative disorders were inoculated into pups in utero. Cell and cell-free preparations from these dogs were also inoculated into the exteriorized fetuses of M. mitis. A persistent leukocytosis has been observed in the marmosa; hematologic and immunologic study of the pups is under way. (auth)

29867 (UCD-472-116, pp 96-9) PATHOLOGIC EFFECTS OF CONTINUOUS ^{89}Sr INGESTION IN MICE: A PRELIMINARY REPORT. Wright, J. F. (California Univ., Davis. Radiobiology Lab.).

Strontium-89 was used in a continuous ingestion experiment to determine the effects of dose rate and age at irradiation on the induction of hematopoietic neoplasms in three inbred strains of mice. Dose-rate effects are evident for hematopoietic tumors in one of the strains utilized and for bone tumors in the other two strains. Differences in age sensitivity at time of irradiation are not yet evident. (auth)

29868 (UCD-472-116, pp 102-4) RADIUM-RELATED NEPHRITIS IN BEAGLES. Bulgin, Marie S.; Richards, W. P. C. (California Univ., Davis. Radiobiology Lab.).

Of seven dogs comprising two litters, two dogs died of renal damage and three showed some clinical signs of renal damage; two other dogs, showing no clinical signs, had histologic changes compatible with renal radiation damage. The most severe damage was observed in the cortex, where there was extensive loss of tubules. A genetic predisposition may contribute to the injury. (auth)

29869 (UCD-472-116, pp 108-9) HYDROXYPROLINE EXCRETION AS AN INDEX OF BONE METABOLISM. Baggs, R. B.; Della Rosa, R. J.; Abrahams, C. D. (California Univ., Davis. Radiobiology Lab.).

Urinary hydroxyproline values obtained on a 48-hr basis did not accurately indicate metabolic activity. Contamination from food and feces resulted in elevated urinary values. Calcium balance fluctuated sufficiently in individual dogs to invalidate differences between dogs or treatment groups (including radium-226-treated dogs). (auth)

29870 (UCD-472-116, pp 110-11) IN VITRO METABOLIC STUDIES OF BONE FROM BEAGLES IRRADIATED WITH ^{60}Co, ^{226}Ra, AND ^{90}Sr. Baggs, R. B.; Della Rosa, R. J.; Abrahams, C. D. (California Univ., Davis. Radiobiology Lab.).

In vitro metabolic bone data obtained from a limited number of control and ^{60}Co-treated dogs indicate that individual differences were greater than treatment differences. Dissimilarities in treatment, age, and pathology preclude evaluation of data in ^{226}Ra- and ^{90}Sr-treated dogs. (auth)

29871 (UCD-472-116, pp 113-18) SURVIVAL OF BEAGLES IN THE INTERNAL EMITTER PROGRAM. Rosenblatt, L. S.; Bielfelt, S. W.; Bustad, L. K. (California Univ., Davis. Radiobiology Lab.).

Preliminary analyses of survival data on dogs up to 8 yr of age that have received ^{90}Sr or ^{226}Ra suggest a dose-effect depression in lifespan at the highest levels of radionuclide administration. No clear difference in mortality to 1 yr of age was evident between groups exposed to ^{90}Sr from in utero and those receiving no ^{90}Sr or ^{226}Ra until 14 mos of age. A marked difference in survival to 8 yr of age was seen for the dogs in the radionuclide study, those in our earlier x irradiation studies, and in the University of Utah's x ray studies. The projected patterns of survival provide a useful basis for long-term plans for research facilities and staff. (auth)

29872 (UCD-472-116, pp 119-20) HEMATOLOGIC AND CYTOGENETIC CHANGES IN MARMOSA INGESTING ^{90}Sr. Wolf, H. G.; Klein, A. Kimiko; Foin, Angela T. (California Univ., Davis Radiobiology Lab.).

Hematological findings on 30 Marmosa mitis fed ^{90}Sr at known dietary levels show no change in erythrocyte values. Total leukocyte counts suggest a depression similar to that seen in beagles fed high levels of ^{90}Sr. Peripheral leukocyte cultures have not shown cytogenetic damage; in one animal, however, about 15% of bone marrow cells sustained lethal damage. (auth)

29873 THYMUS CELL POPULATION STUDIES DURING RADIATION LEUKEMOGENESIS. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore). Contract AT(30-1)-3970. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 729-35(Apr 1970).

The cell population structure and proliferative characteristics in the thymus of young $C_{57}BL$ mice during radiation lymphomogenesis are examined. Initially, there was cellular depopulation followed by regeneration to a normal cell level by about 11 weeks. In a large proportion of animals, however, if the observation period is long enough, at least one surviving cell mutates and the animals develop lymphoma. Tritiated thymidine labeling indexes increased during this period, particularly in the medium and small lymphoid cell compartments, to twice normal levels by 13 weeks, at the time of thymic lymphoma, and to four-fold normal values by 25 weeks, at the time of disseminated lymphoma. The proliferative fraction increased greatly during this interval. This may have been caused by a greater proportion of cells proliferating in the medium and small lymphocyte compartments and bringing into proliferation nondividing cells which still have proliferative potential. However, the proliferation rate is decreased as indicated by an increase in the duration of the median lymphoid cell cycle time in successive generations. On the basis of the proportion of large lymphoid cells, and increased labeling among the small and medium lymphoid cells, it is probable that factors contributing to lymphoma development involve a progressive breakdown of internal and external cellular control mechanisms, loss of the capacity to differentiate among primitive cells and possibly transformation of basically nonproliferating functional end cells to more primitive proliferative forms. (auth)

29874 LASER EFFECT ON DMBA-INDUCED DYSKERATOSES OF THE HAMSTER CHEEK POUCH. Gordon, Thomas E. Jr.; Waldron, Charles A.; Gordon, L. S. (Orange Memorial Hospital, Orlando, Fla.). Cancer; 25: 851-7(Apr 1970).

Results of 21 months of experimental investigation of 120 Syrian hamsters with 9, 10 dimethylbenz (a) anthracene-induced dyskeratoses and subsequent papillomas and squamous-cell carcinomas, and the reaction to treatment of pulsed ruby laser are presented. In addition, tentative results of experiments with continuous argon-ion laser radiation are presented and histopathology of the lesions is reported. Conclusions are given involving statistical analysis of the data which strongly support the hypothesis that pulsed laser radiation has an inhibitory effect on tumor growth, reducing the rate of cell division. On the basis of this work, it is postulated that an approximately eightfold reduction in mitotic rate in hamster oral tumor growth occurs, along with a decrease of incidence of tumor formation to approximately one half of control results. (auth)

29875 EFFECT OF A LARGE DOSE OF IONIZING RADIATION ON DEHYDROGENASE ACTIVITY IN THE RAT BRAIN.

Kozik, M. (Medical Academy, Poznan, Poland). Folia Histochem. Cytochem. (Krakow); 7: 163-78(1969).

The primary changes in the activity of oxidative enzymes in the rat brain after irradiation with 40000 R of x rays were studied. It was shown that this dose brings about a fall in the activity level of the majority of the oxidative enzymes (except the glucose-6-phosphate dehydrogenase) in the neuropil of the brain cortex, cerebellum, and brain base nuclei. In these experimental conditions a general increase in the activity of glucose-6-phosphate dehydrogenase was observed that was absent, however, in the granular stratum of the cerebellar cortex. It was also shown that x rays sometimes cause the dehydrogenase activity to appear or increase in the neurone cytoplasm that prior to irradiation did not exhibit such phenomena. (auth)

29876 LIFETIME BODY WEIGHTS AND MORTALITY DISTRIBUTIONS OF MICE WITH 10 TO 35 GENERATIONS OF ANCESTRAL X-RAY EXPOSURE. Spalding, J. F.; Brooks, Mary R.; Tietjen, G. L. (Los Alamos Scientific Lab., N. Mex.). Genetics; 63: 897-906(Dec 1969).

A comparative investigation of growth and mortality rates of control mice and mice with up to 35 generations of progenitor x irradiation was done. It was concluded that, if minor genetic injury is accumulated through as many as 35 generations of x-irradiated male progenitors (200 rads per generation), it is not reflected in either mortality rate or growth rate. (auth)

29877 EFFECTS OF CHRONIC EXPOSURE OF CHINOOK SALMON EGGS AND ALEVINS TO GAMMA IRRADIATION. Donaldson, Lauren R.; Bonham, Kelshaw (Univ. of Washington, Seattle). Contract AT(45-1)-2056. Trans. Amer. Fish. Soc.; 99: 112-19(1970).

Chinook salmon (Oncorhynchus tshawytscha) eggs and alevins were exposed continuously to low levels of gamma radiation from a ^{60}Co source, from the instant of fertilization until the yolk sac was completely absorbed. The irradiated fish were compared with a similar stock that was not exposed to irradiation. The level of irradiation exposure was gradually increased from 0.5 roentgen/day for the 1960 brood year, to 1.3 roentgens/day in 1965, 2.8 roentgens/day in 1966, 5.0 roentgens/day in 1967 and to 10.0 roentgens/day, a total of 820 roentgens, for the 1968 brood year. At a level of 0.5 roentgen/day no damaging effects were found. The data for the higher levels of exposure will be evaluated as the adults return from the sea. Studies are carried on during the entire life span of the fish. (auth)

29878 INTRACELLULAR REPAIR AND THE OXYGEN EFFECT IN RADIOBIOLOGY AND RADIOTHERAPY. Elkind, M. M.; Withers, H. R.; Belli, J. A. (National Cancer Inst., Bethesda, Md. Univ. of Texas, Dallas). pp 55-87 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

The effects of single and fractionated doses of 2.5 MeV x radiation on the survival and subsequent colony-forming ability of Chinese hamster cells irradiated in air and under hypoxic and oxygen enhancement conditions were studied. Colony formation was used as the criteria for repair of sublethal radiation injury of the cells. The repair of sublethal radiation damage was also studied in cells of mouse skin and mouse intestinal epithelium following exposure of the animals to fractionated doses of x radiation. An initial dose of 700 R was followed by a second dose of 1400 R at varying intervals. Colony formation of epithelial stem cells was used as the criteria for repair of radiation damage. Extrapolation of the results to the survival of cells in irradiated human neoplasms are discussed. It was concluded that if tumors initially contain hypoxic cells, these cells can repair sublethal damage. The first acute radiation dose kills all oxygenated sensitive cells and those that survive were at ages resistant to irradiation and suffer only sublethal damage. These cells proceed to repair the radiation damage as they progress toward cell division, at which time the survivors pass from a resistant to a radiosensitive state. (C.H.)

29879 TIME FACTOR IN DOSE FRACTIONATION. Suit, H. D. (Univ. of Texas, Houston). pp 88-95 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

Time factors in radiation dose fractionation were investigated. Experiments were performed evaluating the response of skin of the thigh of mice and of the mammary carcinoma growing as transplants in the mouse thigh. These experiments employed the split dose technique to evaluate the importance of the time interval between the two doses of x radiation on the moist desquamation of the thigh (DD_{50}) and the tumor cell doubling (TCD_{50}) respectively. For time intervals varying between 1 and 30 days for the normal tissue response and 1 and 13 days for the tumor response observed that the slope of the curve relating DD_{50} and t_i' or TCD_{50} and t_i' were 0.04 and 0.07 respectively when the data were plotted on log-log grids. (auth)

29880 REPOPULATION AND REOXYGENATION AS FACTORS CONTRIBUTING TO THE EFFECTIVENESS OF FRACTIONATED RADIOTHERAPY. Kallman, R. F. (Stanford Univ. School of Medicine, Palo Alto, Calif.). pp 96-108 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

Results are reported from two experiments related to the effectiveness of the use of fractionated radiation dose for therapy. It is pointed out that, in general, repair of sublethal radiation injuries, reoxygenation, and cell repopulation determine the radiosensitivity of tumors. Changes in the radiosensitivity of whole mice during repopulation of cells were investigated by exposure of large population of animals to a dose of 300 R x radiation. At 1.5 hr intervals thereafter groups of 16 animals were exposed to a second dose of 450 R. Mortality data were examined statistically. Death was primarily caused by bone marrow damage and the peak of lethality (8 hr) agreed quite well with current estimates of cell cycle time for hematopoietic cells. Studies on the survival and growth of transplanted tumor cells indicated that tumor radiosensitivity may be triggered into a cyclic pattern by a small dose of radiation. Exponentially growing sarcomas in mice were exposed to a conditioning dose of 300 R x radiation with the animals breathing air and to a second radiation dose after the animals were killed by nitrogen asphyxiation, thereby converting all cells to a state of low oxygenation. The growth rate of tumors following transplantation into normal mice was measured. Starting at 12 hr and subsequently at 2 hr intervals representative tumors were exposed to a second dose of 1200 or 2000 R. Cell preparations of sarcomas from other mice were also irradiated either in vivo or in vitro in suspensions with either oxygen or nitrogen and counted numbers of cells were inoculated into subcutaneous sites in normal recipient mice. The survival of the cells was measured by tumor growth at various times. In both experiments tumor viability decreased abruptly at 14 or 16 hrs followed by a second decrease some 10 to 12 hrs later. The effects of oxygen concentration on the viability of irradiated tumor cells is discussed. (C.H.)

29881 CHANGES OF OXYGENATION IN TUMOURS IN RELATION TO IRRADIATION. Thomlinson, R. H. (Hammersmith Hospital, London). pp 109-21 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

It is postulated that it is unlikely that small neoplasms contain any hypoxic cells and that as tumors grow a proportion of hypoxic cells appears that are caused by inadequate circulation of blood within the tumor. The effects of irradiation on the proportion of anoxic cells in a growing tumor were investigated in mammary carcinomas in mice and experimental tumors in rats irradiated under anoxic conditions, while breathing air, or while breathing oxygen at various pressures. A correlation was found between the proportion of hypoxic cells and the growth rate of the tumors. The response of the tumors to various single and fractionated doses of x radiation was measured by the extent of tumor growth at various times following treatment. (C.H.)

29882 ALTERED FRACTIONATION EFFECTS IN HYPOXIC CELLS. Phillips, T. L. (Univ. of California, San Francisco). pp 122-30 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

Mice were exposed to whole-body x radiation while breathing either air or 50% oxygen for five minutes before and during x irradiation. Bone marrow cells were removed and counted numbers of cells were injected into mice exposed to a total dose of 1000 RADS x radiation. Cells used for transplantation were also irradiated in vitro in air, oxygen, or nitrogen before injection or in vivo after injection into the tail vein. The number of spleen

colonies in the host following transplantation of 10^5 unirradiated bone marrow cells was compared to the number produced by various numbers of irradiated marrow cells following exposure to single or fractionated radiation doses under the various experimental conditions. Dose response curves are discussed in relationship to the effects of hypoxia on the recovery of cells irradiated with various doses and dose fractionation times. (C.H.)

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Refer also to abstracts 29701, 29706, 29709, 29718, 29719, 29756, 29760, 29761, 29768–29770, 29782, and 29783.

29883 (DMRE–69-3, pp 60-81) RADIATION DOSE-RESPONSE RELATIONSHIPS AND HUMAN DISEASE. Bushong, Stewart C. (Baylor Univ., Houston, Tex. Dept. of Radiology).

Radiation in large doses (hundreds of rads) produces serious early and late biological effects in man. In this high dose region the observed effect is usually related to the total radiation dose and can be described by a dose-response relation. Extrapolation of these relations from the high-dose region to the low-dose region can be done only with great hazard and hesitation. It should be emphasized additionally that the presumed radiation effects following low doses of radiation are based on either extrapolation from the high-dose effects or on the tenuous statistical analysis of very few positive cases available from very large numbers of persons at risk. Doses of radiation that are involved in most medical procedures are several orders of magnitude lower than that discussed here. The normal range of radiation doses in diagnostic medical procedures is in the millirad, or thousandths of rads, range. (25 references) (C.O.)

29884 CHANGES IN THE ELECTROPHORETIC PATTERN OF SERUM PROTEINS UNDER THE INFLUENCE OF INCREASING DOSES OF RADIUM GAMMA RADIATION. Wawrzkiewicz, M.; Wieczorek, E.; Wylag, M.; Kwoczynski, Z. Pol. Tyg. Lek.; 24: 354-6(1969). (In Polish).

The divergent results of the effect of ionizing radiation on protein metabolism prompted a study by the method of serum protein electrophoresis in women with grade I cervical carcinoma treated by equal daily doses of radiotherapy. The results of these investigations showed the presence of disturbances of the protein pattern in hypoalbuminemia and hyperglobulinemia, particularly with regard to the $alpha_2$ fraction. No significant differences were observed in the gamma globulin pattern. The differences in the protein pattern were most frequently observed after a total dose of 6720 mgh of radium radiation. (Excerpta Med.)

29885 STUDY OF CHROMOSOME REARRANGEMENT YIELD IN HUMAN BONE-MARROW CELLS AFTER LOCAL GAMMA IRRADIATION WITH ^{60}Co. Shapiro, I. M.; Bigalieva, R. K.; Urbakh, V. Yu. (Inst. of Developmental Biology, Moscow. Inst. of Virusology, Moscow). Dokl. Akad. Nauk SSSR; 189: 1126-8(11 Dec 1969). (In Russian).

Men and women 30 to 75 years of age were given local doses of 100, 300, and 500 rads as treatment for stomach cancer or cancer of the lungs. Samples of bone marrow were taken by sternum puncture 24 hours after the irradiation. Nine patients of each sex who were not subject to irradiation served as the control group. The analysis of chromosome rearrangements was carried out on cells having 46 chromosomes at the metaphase stage. The number of single-hit and two-hit rearrangements increased with dose. The total number of chromosome aberrations was found to be a linear function of x-ray dose. Five patients were given a chest dose of 2500 to 3000 rads, and a sample of bone marrow cells taken from a puncture in the iliac region showed no chromosome rearrangements. The data indicated that chromosomal aberrations in human bone marrow cells can be found only in directly irradiated parts of the body. (TTT)

29886 PROBLEM OF GONADAL DOSES IN ROENTGEN-DIAGNOSTIC IRRADIATIONS. Keler, Aleksandar. Vojnosanit. Pregl.; 25: 307-12(Jun 1968). (In Serbo-Croation).

The overall dangers of radiation to future generations are discussed. The gonads are continually exposed to radiation in the environment. When they are exposed to additional radiation, either x-rays or radiation from ^{90}Sr or other fission products, genetic changes may be expected. In order to decrease the danger of diagnostic doses, it is recommended that in x-ray examinations, the genitals of young persons be protected from radiation. For example, the fringes of a very wide x-ray beam directed to the outstretched hands of a patient will impinge on the genitals, but narrowing of the beam will prevent the unnecessary exposure to the genital region. 21 references are given. (TTT)

29887 RESULTS OF THERAPY OF THYROTOXICOSIS WITH RADIOACTIVE IODINE FROM THE VIEWPOINT OF COMPLICATIONS AND DOSIMETRY. Roehling, S.; Nemec, J.; Silink, K.; Vohnout, S. (Vyzkumny Ustav Endokrinologicky, Prague). Cas. Lek. Cesk.; 108: 1043-9(Jul 1969). (In Czech).

A literature review indicates that radioactive iodine therapy of thyrotoxicosis is valuable in many cases but cannot be used indiscriminately and may cause a subsequent hypothyroid condition. It is generally contraindicated in young persons and pregnant women, but is suitable for patients with cardiac conditions, with thyrotoxicosis complicated with other diseases, and for persons over 45 with certain complications. In each case the physician must consider the possibility of aftereffects since patients treated with radioactive iodine, like surgical patients, may develop an endocrine imbalance. 27 references are given. (TTT)

29888 ACTION OF SMALL DOSES OF RADIOACTIVE RADIATIONS ON THE BODY. Gheorghe, N.; Plesca, I. (Lucrare Efectuato la Centrul de Radiobiologie si Biologie Moleculara, Bucharest). Med. Interna; 21: No. 1, 21-7(Jan 1969). (In Rumanian).

Because of the increasing rate of the peaceful application of radioactivity, the population at large is becoming exposed to radiation. The chief potential hazards consist in the exposure to diagnostic and therapeutic x-rays, internal and external isotopic sources and to a lesser extent, to fallout resulting from atmospheric weapons tests and waste effluents from nuclear plants and laboratories. The sexual cells are especially sensitive to ionizing radiation. Low-level irradiation affects first the synaptic system. No specific threshold value can be established for the radiation; as a general rule, any amount of radiation above the natural level could affect the nervous system and could have genetic consequences. Systems involved in the physiological regeneration of the tissues are also very sensitive. (TTT)

29889 RADIATION CARCINOGENESIS. Warren, Shields (Harvard Medical School, Boston. New England Deaconess Hospital, Boston). Contract AT(30-1)-3777. Bull. N. Y. Acad. Med.; 46: 131-47(Mar 1970). (NYO–3777-31).

Adequate data have been obtained to establish a variety of types of ionizing radiation as a cause of cancer. This holds for a number of different kinds of malignant tumors derived from different cell types. The dose-effect relations are not clear, but in general a greater dose may be correlated with a higher-incidence rate of cancer. The mechanisms for radiation carcinogenesis are more probably multiple than single. (auth)

29890 ALGODYSTROPHY OF THE UPPER LIMB DURING RADIOIODINE TREATMENT. Vignalou, J.; Barre, C. (Hopital d'Ivry, France). Sem. Hop. Paris; 45: 2460-3(8 Oct 1969). (In French).

Two cases of algodystrophy of the upper limb after treatment of hyperthyroidism with radioiodine are presented and the possible mechanism of this rare complication is discussed. (auth)

29891 LATE RADIATION INJURIES OF THE SMALL INTESTINE. Graudins, J. (Chirurgesche Klinik, Luebeck, Ger.). Langenbecks Arch. Chir.; 324: 120-30(28 Apr 1969). (In German).

Radiation injuries of the small intestines were described for 15 patients given x-ray doses of 8,000 to 13,000 R, plus 4,000 mg-hr of intracervical Ra treatment. Of these, three had received doses of 8,000 R of ^{60}Co irradiation instead of the x radiation. Symptoms of radiation injuries of the small intestine included peritonitis, intestinal hemorrhages, diarrhea, chronic meteorism, nausea, anemia, anorexia, weight loss, constipation, and abdominal pains. Pathohistological changes included histiocytic cell infiltration, tissue fibrosis, obliterative vasculitis and cell necrosis, stenoses, ulcerations, perforations, fistulas, and severe adhesions. In most cases the terminal ileum was involved, and irradiation injury of the jejunum was infrequent. The development of these symptoms varied considerably between patients and the size of the irradiation doses. Other factors that seemed to affect the incidence of irradiation injuries of the intestine were the size of the radiation field, ionization density, age of the patient, differentiation of the cells, O_2 concentration of the cells, sensitizing effect of hyperemia, and the water content of the tissue. Apart from the acute, initial symptoms that appeared during and immediately after radiotherapy, the patients were generally symptom-free for many years afterward. Out of the 15 patients, 12 were subjected to surgery because of small intestinal injury during the first 2 yr following radiotherapy. Other patients were treated for irradiation effects on the small intestine from 7 to 22 yr after irradiation. (BBB)

Radiation Effects on Plants

Refer also to abstracts 29899 and 29900.

29892 (UCRL-18793, pp 92-9) THE OXYGEN EFFECT OF π^-MESONS IN VICIA FABA. Raju, Mudundi R.; Amer, Nabil M.; Gnanapurani, Madvanath; Richman, Chaim (California Univ., Berkeley. Lawrence Radiation Lab.).

Results showed a significant reduction in oxygen enhancement ratio (OER) for stopping π^-mesons in spite of contamination in the beam. The OER should be lower for a pure beam. (auth)

29893 CONTRIBUTIONS TO THE USE OF X RAYS, UV, AND IF RADIATION IN VINE GROWING. Calistru, Gh. Rev. Hort. Viticult.; 17: Nos. 7-8, 76-80(1968). (In Rumanian).

The separate and cumulative action of x rays, radiation, and radiations on vine yield were studied. The experiments were performed at the Minis-Arad horticultural-viticultural station on a clay-sandy soil with a poor supply of fertilizers. As test vine, the Merlot type grafted on Berlandieri x Riparia Kober 5 BB Selection Craciunel. 2 was used. It was found that a 4-R radiation dose had a stimulating effect on grafts by enhancing the biochemical processes with the result of good callosity and a quicker vascularization of grafted vines. If the parents were irradiated before grafting, an improved callosity at the grafting point and at the base was observed. In addition, root formation was also stimulated. If grafts alone are treated, standard vine results in high quality and quantity yields as against controls and the other variants. The uv and ir radiations delivered during the vegetative period stimulated offshoot growth at the beginning and increased the production of grafted vine. (Rom. Sci. Abstr.)

Radiation Effects on Microorganisms

Refer also to abstracts 29733 and 29737.

29894 (UCRL-18793, pp 19-24) ISOLATION OF DISOMICS IN SACCHAROMYCES CEREVISIAE. Tauro, Patric; Rodarte-y-Ramon, Ubaldo S.; McKey, Tommy J.; Mortimer, Robert K. (California Univ., Berkeley. Lawrence Radiation Lab.).

A method for the isolation of disomics in yeast by the use of a system containing a set of noncomplementing alleles is described. The disomic isolated by this procedure has been investigated for its disomic status. The x-radiosensitivity of the disomic was compared with that of the parental strains. The data suggest that the extra chromosome present in DS-542-VII is functional and that the strain is stable. (C.O.)

29895 NEW DATA ON THE INFLUENCE OF UV IRRADIATION OF THE POLYOMA VIRUS ON TRANSPLANTATION ANTIGEN. Meyer, G.; Fondarai, J.; Bonneau, H. (Centre Regional de Lutte Contre le Cancer, Marseille). Compt. Rend. Soc. Biol., 162: 2171-3(1969). (In French).

It was shown in preceding studies that polyoma virus, irradiated with uv light produces a transplantation antigen of diminished effectiveness. This study further elaborates this fact. Method used and statistics applied have been described in an earlier paper (C. R. Soc. Biol., 1968, vol. 162, p. 1535). Three series of hamsters were examined: the first received 10^6 U.F.P. (plaque-forming units) of polyoma virus; the second received 10^5 U.F.P.; the third 10^6 U.F.P., irradiated with 30,000 ergs/mm^2 uv light. A fourth series served as control. One month afrer inoculation the hamsters showed 15, 150, and 1500 tumor cells, respectively. A table gives the results of a statistical analysis of the experimental data. They are summarized as follows: 10^6 U.F.P., F 4.33; 10^5 U.F.P., F 0.87; 10^6 U.F.P. (irradiated), same as 10^5 (not irradiated); controls; F 15.42. This proves the diminution of the protective power of graft antigen by uv irradiation, and particularly the remarkable fact that protection obtained by a polyoma virus irradiated with 30,000 ergs/mm^2 uv-light, is 10 times weaker than that obtained by the same unirradiated polyoma virus. (F.J.W.)

29896 ISOLATION, CHARACTERIZATION, AND GENETIC ANALYSIS OF OSMOTIC MUTANTS OF NEUROSPORA CRASSA. Mays, Laura Livingston (Yale Univ., New Haven). Genetics; 63: 781-94(Dec 1969).

Ultraviolet induced Neurospora crassa mutants of the osmotic phenotype characterized by inhibition of growth at high osmolalities of growth medium were isolated by filtration concentration from 3% NaCl medium and by selecting semicolonial isolates of a colonial mutant. From a total of 132 salt-sensitive mutants isolated, 14 mutants that crossed well were studied in detail. In addition, nine osmotic strains isolated by other investigators were studied. All of the osmotic mutants mapped at one of six loci on linkage group I. The positions of all of the loci except os-1 were verified by means of three-point crosses with known linkage group I markers. Complementation patterns, obtained using forced heterocaryons, corresponded to the genetically defined loci. There was some evidence for weak intragenic complementation at four of the six loci studied. The osmotic phenotype was recessive in all cases. The strains were characterized as to their levels of osmotic sensitivity, but no obvious correlations between these levels and the various osmotic loci were found. (H.B.G.)

29897 FURTHER OBSERVATIONS OF THE OXYGEN EFFECT IN BACTERIAL CELLS IRRADIATED WITH HIGH INTENSITY PULSED ELECTRONS. Epp, E. R. (Sloan-Kettering Inst. for Cancer Research, New York). pp 46-54 of Frontiers of Radiation Therapy and Oncology. Vol. 3. The Relationship of Time and Dose in the Radiation Therapy of Cancer. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From Third Symposium on Frontiers of Radiation Therapy and Oncology, San Francisco, Calif. See CONF-671075-(Vol. 3).

The effects of single pulse irradiation with high energy (520 keV) electrons on Escherichia coli exposed under various oxygen concentrations were measured. Colony-forming-ability was the biological endpoint used to determine survival as a function of absorbed radiation dose. Thermoluminescent (CaF_2 : Mn) dosimeters were found to be satisfactory for measurement of the dose from high energy pulsed electrons. (C.H.)

Radiosterilization and Radiopreservation

Refer also to abstracts 29714 and 31120.

29898 CURRENT TRENDS IN FISH HANDLING AND PROCESSING. Sidhu, G. S.; Montgomery, W. A. (Commonwealth Scientific and Industrial Research Organization, Ryde, Australia). Food Technol. Aust.; 21: 642-5(Dec 1969).

Irradiation pasteurization of fish is reviewed, with Australian applications considered. Radiation sterilization is compared with heat sterilization from a competitive viewpoint. (Australia)

29899 SPROUT INHIBITION OF ONIONS BY IONIZING RADIATION. PART 1. EFFECT OF DELAY BETWEEN HARVEST AND IRRADIATION ON SPROUTING OF VAR. SAPPOROKI AND SENSHUKI. Umeda, Keiji; Takano, Hiroyuki; Sato, Tomotaro (Food Research Inst., Tokyo). Shokuryo Kenkyujo Kenkyu Hokoku; No. 25, 24-31(Feb 1970). (In Japanese).

The effect of ^{60}Co irradiation on the sprouting, weight loss, and decayed ratio of onion variety Sapporoki and Senshuki was studied. Almost complete suppression of sprout growth was attained in variety Senshuki at the dose of 7 krad, when the radiation treatment was conducted from 20 to 60 days after the harvest. When the onions were irradiated up to 15 krad within 60 days after harvest, the percentage of sound onions (not sprouted or decayed in 8 months after the harvest) was 0%, 23.8 to 47.0%, and 49.1 to 84.3%, respectively, for the non-irradiated sample, irradiated samples stored at room temperature, and irradiated samples stored at 5°C. In the case of Sapporoki, no difference was observed in sprouting ratio between the irradiated and the non-irradiated samples and even the highest dose of 15 krad did not entirely suppress the growth of sprouts. (auth) (NSA of Japan)

29900 RADIATION EFFECTS ON PLANT TISSUE. PART 2. EFFECTS OF CATHODE RAY ON THE REHYDRATION OF DRIED VEGETABLES SUCH AS POTATO, BURDOCK, CARROT, AND ONION. Takano, Hiroyuki; Umeda, Keiji; Sato, Tomotaro; Sugawara, Katunori (Food Research Inst., Tokyo). Shokuryo Kenkyujo Kenkyu Hokoku; No. 25, 32-6(Feb 1970). (In Japanese).

In order to reduce the cooking time of dried vegetables, dried samples of potato, burdock, carrot, and onion were irradiated with 1 MeV of cathode ray and their water absorption ratio, swelling velocity, hardness, and rehydration mechanism were investigated. The rehydration patterns of carrot-onion and potato-burdock that were blanched with 1% of saline solution before dehydration resembled each other The weight of absorbed water in dried vegetables blanched with 50% aqueous solution of lactose was much lower than that of blanched with saline solution. The rehydration mechanism was changed by the cathode-ray irradiation and the total volume (sample + water) was decreased remarkably with a little change in the ratio of water absorbed. The cooking time was reduced markedly with the radiation treatment without off-flavor occurrence. The water absorption and the hardness of vegetables after the optimum cooking time were decreased with increasing dose of radiation. (auth) (NSA of Japan)

29901 EFFECT OF IONIZING RADIATION ON STARCH. PART 3. DIGESTIBILITY OF IRRADIATED POTATO STARCH. Umeda, Keiji; Hayakawa, Seiichi; Hayakawa, Akira; Toyoshima, Hidechika; Miyazaki, Hidemoto (Food Research Inst., Tokyo).

Shokuryo Kenkyujo Kenkyu Hokoku; No. 25, 11-16(Feb 1970). (In Japanese).

Potato starches irradiated with cathode rays (max. 10 Mrad) were examined for their decomposition products and digestibility. Fractions soluble in 70% ethanol including dextrin, maltose, and glucose were increased with dose of radiation. No differences were detected in fermentation ratio between non-irradiated and irradiated starches up to the doses of 10 Mrad. Enzymatic digestibility of irradiated raw potato starch was raised with dose of radiation. Digestion ratios of 5 and 10 Mrad starches with the small intestine extract for 40 hrs. were 13.3 and 17.8%, respectively, of initial starch. Voluntary feeding test of irradiated raw starch for rats showed no difference in the feeding efficiency between non-irradiated and irradiated starch up to 10 Mrad. But the adsorption ratio of irradiated starch was increased with the dose of radiation; non-irradiated and 10-Mrad irradiated were 49 and 57%, respectively. Percentage of cecum against body weight after feeding irradiated raw starch for 14 days decreased with increasing dose of radiation, that is, 9.7, 5.5, and 3.5%, respectively, for non-irradiated, 5 Mrad, and 10 Mrad starches. Limited feeding tests of irradiated raw starch for rats showed that both feeding efficiency and weight gain increased with increasing dose of radiation. (auth) (NSA of Japan)

29902 RADIATION TREATMENT OF RICE. PART 2. GAMMA RAY IRRADIATION OF BROWN RICE. Kawashima, Koji; Takano, Hiroyuki; Umeda, Keiji; Sato, Tomotaro (Food Research Inst., Tokyo). Shokuryo Kenkyujo Kenkyu Hokoku; No. 25, 17-23(Feb 1970). (In Japanese).

The effects of γ irradiation on the quality of various Japanese rices were investigated Six varieties of Japanese rice harvested in 1966 were treated with 10 to 30 krad and stored for three or six months. Five varieties harvested in 1967 were irradiated up to 50 krad and stored for eight months. All rices were stored at room temperature. There was not much significant difference between irradiated and unirradiated rice of 1966 after three months storage. The difference became less with longer preservation period. For the rice varieties gathered in 1967, the following results were obtained. Immediately after the irradiation of 30 krad, significant differences were detected, but they became smaller with the storage time. Every variety showed the decrease of quality owing to long preservation irrespective of the radiation treatment. The threshold dose level that affects the quality of rice after eight months storage was about 45 to 50 krad. The better-quality rice seemed to have a higher threshold dose. (auth) (NSA of Japan)

29903 SOME ASPECTS OF THE RATE OF APPEARANCE AND TYPE OF MICROBIOLOGICAL DAMAGE IN IRRADIATED BANANAS. Chowdhury, S. U.; Hamid, M. A. (Atomic Energy Centre, Dacca, Pakistan). Food Irradiat.; 10: 18-24(Jul-Dec 1969).

The gamma irradiation effect from a ^{60}Co source on the pattern of microbiological decay of bananas, AMRITASAGOR, which is a popular Pakistani variety as well as on the extension of shelf life was investigated. A great reduction in the total counts of bacteria on the first day of storage was obtained at 40, 50, and 60 krad doses. At these doses the spoilage of bananas was as quick as with the controls, and unlike the controls the bacterial counts did not show any definite trend in development or decrease. At 10, 20, and 30 krad doses, although there was no initial reduction in the total counts on bananas, on the immediately following days there was an appreciable decrease in the bacterial counts. At these doses a 3-day extension of shelf life was observed. (auth)

29904 PRESERVATION OF VEGETABLES BY IRRADIATION IN IRAN. Rouhanizadeh, N. (Teheran Univ.). Food Irradiat.; 10: 8-12(Jul-Dec 1969).

Radiopreservation of vegetables was studied in Iran. Onions, tomatoes, and potatoes were irradiated with a ^{60}Co γ-source and their storage time observed over several months. In γ-irradiated potatoes, the number of sprouts was considerably reduced. The same results were obtained for onions. An increase in storage time for tomatoes was observed but further investigations were suggested. (H.B.G.)

29905 EFFECT OF GAMMA RADIATION ON THE BIOCHEMICAL AND ORGANOLEPTIC PROPERTIES OF BASMATI RICE. Nadeem, Muhammad Tahir; Sattar, A.; Muntaz, Ali; Amir, Muhammed (Atomic Energy Centre, Lahore). Food Irradiat.; 10: 13-17 (Jul-Dec 1969).

Effects of gamma irradiation on biochemical and organoleptic properties of rice were investigated. The basmati-370 rice of West Pakistan was irradiated at doses of 14, 16, 18, 20, 25, 30, 35, and 40 krad of gamma radiation. The results showed that irradiation up to 40 krad did not cause any significant change in the moisture, nitrogen, protein, fat, and amino acid contents of rice. There was no change in the organoleptic characteristics of irradiated rice as compared to the unirradiated control. (auth)

29906 PASTEURIZATION OF PACIFIC OYSTERS BY RADIATION: POST-MORTEM CHANGES IN NUCLEOTIDES DURING STORAGE AT 0 TO 2°C. Guardia, Enrique J.; Dollar, Alexander M. (Univ. of Washington, Seattle). Contract AT(45-1)-1730. J. Food Sci.; 35: 22-5(Jan-Feb 1970).

The effects of ice storage and γ radiation processing in the content of nucleotides in oysters were investigated. The concentration of nucleotides was lower in the adductor muscle of the oyster (1.64 μmoles/g) than in the remaining dark tissues of the oyster (2.75 μmoles/g). The concentration was less in the whole oyster meats (2.87 μmoles/g) than is usually found in fish muscle, or other marine invertebrates. In addition to the adenine nucleotides and inosine monophosphate, uridine triphosphate, guanosine triphosphate, guanosine diphosphate, guanosine monophosphate, and guanosine diphosphate-mannose were found in the fresh oysters. Samples collected in summer had greater concentrations of nucleotides than similar winter samples. Inosine monophosphate formed rapidly from adenosine triphosphate during storage at 0 to 2°C, while the turnover rate of inosine monophosphate was slow and reflected low 5′-nucleotidase activity. Hypoxanthine, inosine, guanosine, guanine, and uracil were formed during ice storage. The nucleotide breakdown in oysters was not changed by 2 mrads of γ radiation dose. Total nucleosides and free bases increased during storage of both unirradiated and irradiated samples. During the latter part of the storage period the concentrations of nucleosides and free bases were considerably greater in the irradiated samples. This difference probably was caused by the utilization of these compounds by bacteria in the unirradiated samples. After 15 days of storage bacteria had increased to more than 10^6 organisms per g, while the counts for irradiated samples were very low (less than 10^3 per g). (C.H.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 29486.

29907 ENGINEERS'S GUIDE TO HIGH-TEMPERATURE MATERIALS. Clauss, Francis J. Addison-Wesley Series in Metallurgy and Materials Science. Reading, Mass.; Addison-Wesley Publishing Company, Inc. (1969). 409p.

This book is designed for those who use materials at elevated temperatures and who seek a better understanding of the materials available. The information is presented in three sections. The first defines the gross mechanical behavior of metals and alloys at high temperatures and discusses the metallurgical factors that influence this behavior. The second section categorizes a number of specific materials according to their composition and structure and indicates the effects of changes in alloy compositions on the behavior of high-temperature materials. The third section includes special topics e.g., design considerations at elevated temperatures, mathematical analysis of creep-rupture behavior, the effects of intermittent loads and temperatures and the effects of notches on creep-rupture behavior, mechanical fatigue at high temperatures, and thermal stresses in ductile metals and alloys. (L.C.L.)

29908 DISKUSSIONSTAGUNG BERYLLIUM. Kurzfassung der Referate, in Stuttgart, 14. und 15. November 1968. (Discussion on Beryllium. Conference held in Stuttgart, November 14–15, 1968). Bonn; Deutsches Atomforum e.V. (1968). 15p. (In German and English). (CONF-681135).

The development of beryllium technology in the United Kingdom is summarized. Although the large scale application of beryllium as a fuel element tube for the Advanced Gas Cooled Reactor was abandoned, it has been utilized in a number of minor roles in nuclear physics (x-ray windows, accelerator targets, neutron sources). The major development programs have been outside the nuclear field utilizing the materials outstanding stiffness characteristics in aerospace structures and gyroscope components. The status of beryllium fabrication in the United Kingdom is established showing the relative availability of metal in a variety of semi-finished forms (sheet, forgings, and extrusions). The need for engineers to design to accommodate brittleness characteristics is proposed as the only course available for early application and exploitation of this attractive material. (J.R.D.)

Corrosion and Erosion

Refer also to abstracts 29450 and 31057.

29909 (AECL–3551) ENVIRONMENTALLY INDUCED CRACKING OF ZIRCONIUM ALLOYS. I. TOPOGRAPHY OF STRESS CORROSION CRACKING IN METHANOLIC SOLUTIONS. Cox, B. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jan 1970. 24p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

A comparison between the stress corrosion cracking of zirconium alloys (in methanol, methanol/iodine and methanol/HCl solutions) and the published behavior of titanium in the same solutions shows a close similarity. The fracture surfaces produced in these solutions have been examined using a scanning electron microscope, and specimen sections have been examined metallographically. In methanol/iodine solutions zirconium alloy stress-corrosion cracks propagate almost completely intergranularly. In methanol/HCl solutions, however, stress-cracking may be partially transgranular. Intergranular penetration provides the initiation step, in this instance also, and for specimens lowly stressed the fracture surface is predominantly intergranular. The degree of transgranular cracking appears to be related to the rate of crack propagation rather than to the absolute stress level in the specimens, or to their oxygen content. (auth)

29910 (DP(NASA)–1179) CHLORINE GAS AND FLUORIDE ION IN HOT-SALT STRESS CORROSION CRACKING OF TITANIUM–ALUMINUM ALLOYS. Ondrejcin, Robert S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar 1969. Contract AT(07-2)-1. 19p. Dep. CFSTI.

In hot-salt stress corrosion cracking of titanium, chlorine is not the cracking agent at the nominal cracking temperature of 290°C. Above 650°C, however, chlorine does take part in corrosion of titanium. In the cracking process, pyrohydrolytic formation of a hydrogen halide rather than chlorine is indicated. In the salt-titanium reaction at 260 or 400°C, chlorine was not found by mass spectrometry, nor was chlorine observed at 340 or 650°C by ultraviolet spectroscopy. At 650°C, the ratio of HCl/Cl_2 was greater than 105/1, based on the limit of detection by ultraviolet spectroscopy. Sodium fluoride does not cause hot-salt titanium stress corrosion cracking as do the other sodium halide salts because NaF absorbs much less water, and NaF-coated specimens do not absorb hydrogen generated during corrosion reactions. It is postulated that hydrofluoric acid produced pyrohydrolytically from NaF attacks the metal surface, but both the hydrogen liberated in the attack and the directly affected titanium surface layer are removed from the system by the simultaneous formation and sublimation of TiF_4. Corrosion of titanium by NaCl at 315 and 480°C was due to moisture in the reagents rather than to a "reducible oxide" (TiO_2) as had been proposed. (auth)

29911 (LIB/Trans–245) INFLUENCES OF RADIATION ON THE OXIDATION OF ZIRCONIUM ALLOYS IN HIGH TEMPERATURE WATER. EXAMINATION OF THEIR BEHAVIOUR IN SUPERHEATED STEAM. Blanchet, J. Translated by W. Buykx (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Bull. Inform. Sci. Tech. (Paris), No. 139, 47-58(Jul-Aug 1969). 15p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 24: 956. (France)

29912 (MLM–1720) HIGH TEMPERATURE REACTIONS OF GROUP VI-A METALS WITH LUTETIUM AND FOUR REFRACTORY METALS. Matson, L. K. (Mound Lab., Miamisburg, Ohio). 20 May 1970. Contract AT-33-1-GEN-53. 14p. Dep. CFSTI.

To obtain the reaction data between chalcogens, which are used as nonradioactive substitutes for polonium, and potential container metals, an apparatus was developed for monitoring the reaction between the metals and chalcogens. The reaction between tellurium and each of the metals lutetium, molybdenum, tantalum, tungsten, and rhenium was studied. The lutetium, molybdenum, and tantalum data were also described by the general parabolic equation. The preliminary data indicate that rhenium would be a good container material, that tungsten would be a fair container material, and that molybdenum, tantalum, and lutetium would be poor container materials for tellurium and polonium. Further studies to test the container capabilities of rhenium were performed. Since it was not possible to conduct experiments using polonium at this time, corrosion experiments using tellurium and selenium were performed to determine whether there would be a reasonable probability of developing an isotopic fuel container for polonium using rhenium. The data suggest that rhenium might be a good container for polonium. Thus, corrosion studies between rhenium and polonium are suggested. (auth)

29913 (UCRL-Trans–10454) TEMPERATURE DEPENDENCE OF THE STRENGTH, PLASTICITY, AND ELASTIC PROPERTIES OF ALLOYS OF URANIUM WITH ZIRCONIUM, NIOBIUM, AND MOLYBDENUM. Bugrov, V. A.; Grigorovich, V. K.; Ivanov, O. S. Translated by A. M. A. Mincer for Univ. of California Lawrence Radiation Lab., Livermore, from pp 62-9 of Fiziko-Khimiya Splavov i Tugoplavkikh Soedinenii s Toriem i Uranom, Izdatel'stvo Nauka, Moscow, 1968. 21p. Dep. CFSTI.

Investigation of the temperature dependence of the strength of uranium alloys U + 20 at % Zr, U + 70 at % Zr, U + 20 at % Nb, U + 20 at % Mo, U + 7.5 at % Zr + 15 at % Nb, and U + 10 at % Zr + 20 at % Nb showed that below the transformation temperature (at 500°C) the U + 20 at % Zr and U + 70 at % Zr alloys are stronger than the U + 20 at % Nb (or U + 20 at % Mo) alloys, but not so strong as the compositions U + 10 at % Zr and U + 20 at % Nb. In the γ state (at 700 to 900°C) the U + 20 at % Zr and U + 70 at % Zr alloys are far weaker than U + 20 at % Nb and U + 20 at % Mo. The ternary composition U + 10 at % Zr + 20 at % Nb is the one most heat resistant in the γ range. The Young's modulus of the U + 70 at % Zr, U + 20 at % Nb, U + 20 at % Ti and U + 7.5 at % Zr + 15 at % Nb decreases smoothly to temperatures of phase transformation, then falls sharply within the phase transformation interval, and finally continues to decrease slowly at higher temperatures. (auth)

29914 (UCRL-Trans–10455) CORROSION RESISTANCE IN WATER OF SOME ALLOYS OF URANIUM WITH ZIRCONIUM, NIOBIUM, AND MOLYBDENUM. Kishinevskii, V. B.; Gomozov, L. I.; Ivanov, O. S. Translated by A. M. A. Mincer for Univ. of California Lawrence Radiation Lab., Livermore, from pp 81-6 of Fiziko-Khimiya Splavov i Tugoplavkikh Soedinenii s Toriem i Uranom, Izdatel'stvo Nauka, Moscow, 1968. 11p. Dep. CFSTI.

Results of investigations showed that in the U–Zr–Nb system, the alloys U + (20–30) at % Nb and U + 20 at % Zr proved to be the most resistant to corrosion after quenching in water at 100°C. After tempering the corrosion stability is sharply decreased. The alloys most resistant under the testing conditions were U + 10 at % Zr + 10 at % Nb, U + 30 at % Nb, and U + 15 at % Zr + 15 at % Nb. The corrosion resistance of quenched U–Zr–Mo alloys in water at 100°C is lower than that of the corresponding binary alloys. After tempering, the lowest resistance was found for the alloys in which the Zr:Mo ratio was 1:3. The alloy having the composition U + 30 at % Mo proved to be the most stable in this system. A broad range of alloys resistant to corrosion in water at 100°C in the quenched state has been found in the U–Nb–Mo system. After tempering the alloys U + 15 at % Nb + 5 at % Mo and U + 22.5 at % Mo + 7.5 at % Nb had the highest resistance. Alloys of the 80 at % U section in the U–Nb–Mo system and of the 70 at % U section in the U–Zr–Nb system had the highest corrosion resistance in water at 250°C. (auth)

29915 COMBUSTION PROPAGATION OF TUNGSTEN DELAY POWDERS. Zimmer-Galler, R. (Naval Ordnance Station, Indian Head, Md.). pp 4.6.1-14 of Proceedings of the Sixth Symposium on Electroexplosive Devices, Held in San Francisco, Calif., July 8–10, 1969. Philadelphia; Franklin Inst. Research Labs. (1969).

See CONF-690720.

Investigation results on combustion of delay compositions using varying proportions of W, barium chromate, potassium perchlorate, and diatomaceous earth are reported. It was found that solid phase-gas phase reactions are involved. The specific surface area of W is believed to be the primary burn-rate-control factor. (J.R.D.)

29916 OXIDATION KINETICS OF TUNGSTEN. Ageev, V. N.; Ionov, N. I. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 11: 2593-5(May 1970).

Translated from Fiz. Tverd. Tela; 11: 3200-2(Nov 1969).

The temperature dependence of the amounts of the molecules WO, WO_2, WO_3, and $(WO_3)_2$ desorbed during a flash, with various times of preliminary oxygen adsorption were studied, using flashes in a pulsed time-of-flight mass spectrometer. It is shown that for all temperatures T_α of the W absorbent, formation of oxide structures begins only after formation of a layer of chemisorbed oxygen on the surface whose formation time depends on T_α. Desorption of oxides occurs as two phases — a high-temperature β_2 phase and a low-temperature β_1 phase. The initial rates of formation of the oxide structures in the β_1 and β_2 phases depend on the temperature T_α. A probable explanation for the observed dependence of the oxidation kinetics of tungsten is given. (auth)

29917 PROTECTION OF NIOBIUM AND ITS ALLOYS IN A HIGH TEMPERATURES AND STRONGLY ATTACKING ATMOSPHERE. Ferrari, A.; Vicentini, B.; Wolfsgruber, C. (Consiglio Nazionale delle Ricerche, Milan). Met. Ital.; 62: 71-6 (1970). (In Italian).

This work represents a review of the studies and experimental results which were obtained on the protection of niobium and its alloys in oxidative environments for up to 1500°C temperatures. Such protection could be obtained in two ways: by addition of elements depressing the Nb_2O_5 concentration present in the surface layer, in favor of other niobium oxides which were more oxidation-resisting; and by means of protective coating deposition. The results obtained by means of zinc, aluminum, and silicide coatings are briefly reported. The possibility of extending the life of the protective intermetallic layers was suggested; this could be obtained by associating the antioxidative coating with an antidiffusive barrier compatible with the niobium alloys and the coating itself. (auth)

29918 EFFECTS OF ALLOYING ELEMENTS ON THE PITTING CORROSION OF ALUMINUM. Sugimoto, Katsuhisa; Sawada, Yoshinobu; Morioka, Susumu (Tohoku Univ., Sendai). J. Jap. Inst. Metals; 34: 312-18(Mar 1970). (In Japanese).

The effects of alloying elements on the pitting corrosion of aluminum were investigated. Twenty-two kinds of binary aluminum alloys were prepared and their electrochemical properties were measured in 1 N NaCl solution. The shift of the pitting potential of aluminum was observed in alloys containing more than 0.6% alloying elements. Pitting potentials of binary aluminum alloys with 5 to 10% alloying elements were, in order from noble to less noble: Al–Cu > Al–Ni > Al–Fe, Al–Si > Al–V > Al–Mn, Al–Cr, Al–B > Al–Zr > Al–Ti > Al–Mg > Al–Be. Effects of alloying elements on the pitting dissolution rate in the decreasing order of activity were: Fe > Mg > Mn > Si > Cu. This agreed with the order of effects of the alloying elements on the number of pits observed for a given time. The cathodic polarization in a neutral solution of NaCl was large for the aluminum alloys containing Mn, Mg, and Si, but it was very small for the alloys containing Fe and Cu. Since the pitting corrosion in the neutral solution depended upon the cathodic reactions, it was preferable to alloy the elements which increased the cathodic polarization in order to increase resistivity against pitting corrosion. (auth)

Preparation and Fabrication

Refer also to abstracts 29304, 29452, 29455, 29494, and 30287.

29919 (BNWL-1376) CHEMICAL-MECHANICAL CLEANING OF SMALL-DIAMETER TUBING. Studer, R. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. Contract AT(45-1)-1830. 13p. Dep. CFSTI.

One requirement of FTR fuel cladding tubes is freedom from contaminating substances, particularly on internal surfaces. Other technical requirements of the tubes can only be met by tube manufacturing methods which, inherently, make cleaning difficult. Visual or mechanical examination of small-diameter tubes to determine presence or absence of gross soils is uncertain and may be damaging. The best assurance of uniform cleanliness is a completely effective cleaning operation. Such an operation has been developed, and a brushing/rinsing machine has been designed to make it practical. The machine was designed to give maximum protection to the tube being cleaned. (auth)

29920 (CONF-700502–, pp 59-73) EFFECT OF RADIATION LEVELS FROM PLUTONIUM ON FUEL FABRICATION PROCESS DESIGN. Smith, R. C.; Faust, L. G.; Van Tuyl, H. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

The results of radiation measurements made on high exposure Pu are presented and the effects that these radiations will have on the design of fuel fabrication facilities using such Pu are discussed briefly. The increase in dose rate from Pu with time, due to the growth of daughter products from ^{241}Pu and ^{236}Pu, will be sufficient to make prompt refabrication of nuclear fuels an important factor. For most of the Pu produced in the late 70's, the γ, x-ray surface dose rate will approximately double within one year after chemical purification. Despite rather high γ, x-ray surface dose rates, the neutron dose contribution will probably produce the most difficult shielding problems, particularly in fast reactor fuels production facilities. Some shielding will be necessary in future fuel manufacturing plants using high burnup Pu. The most economical process will use shield designs in which the interaction of several additional considerations are incorporated including: criticality specifications, both neutron and γ shielding, mechanization, unit-mass station control, provision for rapid analytical results, and continuous accountability. (auth)

29921 (CONF-700502–, pp 85-98) FABRICATING PRODUCTION QUANTITIES OF HIGHER BURN-UP PLUTONIUM FUELS. Frankhouser, William L.; Decher, U.; Potter, T. E. (Nuclear Materials and Equipment Corp., Apollo, Pa.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Approximately 2,720 kg of Pu as metallic nuclear fuel were processed for the Zero Power Plutonium Program. Both ^{240}Pu and ^{241}Pu isotopic compositions in these fuels approached levels anticipated in reactor-grade Pu. This production experience was evaluated in terms of health and safety problems and facility costs in anticipating design criteria for a production oxide plant for Pu recycle fuels. (auth)

29922 (IS-RD-21) REACTOR MATERIALS DEVELOPMENT. Quarterly Report, January–March 1970. Voigt, A. F. (ed.) (Ames Lab., Iowa). 15p. Dep. CFSTI.

Research progress is reported on preparation of thorium and other reactor materials, phase studies of rare earths and refractory metal systems, and properties of reactor materials at high temperatures. (J.R.D.)

29923 (NLCO-1052) MULTIPLE DIRECT CASTING OF NPR BILLETS FROM A SINGLE MELT. Titmuss, R. J. (National Lead Co. of Ohio, Cincinnati). Apr 1970. Contract AT-(30-1)-1156. 15p. Dep. CFSTI.

Techniques were developed to cast NPR billets directly to size in multiple molds thereby eliminating an extrusion operation. Induction-heated tundishes were used to distribute the uranium metal from a graphite crucible into three graphite molds for the inner billet and two graphite molds for the outer billet. The machined billets were within all specifications except for surface quality. Very minute subsurface defects became visible after nitric acid pickling. Alloying additions of aluminum were made by introducing the aluminum, as pellets, directly into the molds. The aluminum was well distributed in the castings. (auth)

29924 (WARD-3791-46) VANADIUM ALLOY CLADDING DEVELOPMENT. Quarterly Progress Report for the Period Ending March 31, 1970. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Apr 1970. Contract AT(30-1)-3791. 25p. Dep. CFSTI.

Preparation of V and V alloys for stability evaluation and corrosion testing is summarized. Results of irradiation testing of vanstar-8 and vanstar-9 are reported. (J.R.D.)

29925 ELECTRIC CONDUCTIVITY AND PRODUCTION OF INDIUM-CADMIUM ALLOYS. Predel, B.; Sandig, H. (Univ., Muenster, Ger.). J. Less-Common Metals; 21: 71-80(1970). (In German).

Based on the specific electrical resistance obtained by an induction method on liquid and solid In-Cd alloys of the entire concentration range from 0 to 100% Cd, it was possible to show special bonding conditions at concentrations in the vicinity of 15 at. % Cd and 75 at. % Cd. These bonding conditions led to the formation of intermetallic phases in the solid state. These findings were in agreement with the variation of the partial enthalpies of mixing as a function of the concentration for the alloys in question. The dissociation energy of clusters having bonding conditions and atomic configurations which were thought to be analogous to those of the solid compound $InCd_3$, were determined to be 4.7 kcal/g-atom from the temperature dependence of the specific electrical resistance at about 75 at. % Cd. (auth)

29926 VACUUM CHAMBER SEGMENTS OF ALUMINA CERAMICS WITH CONNECTING METAL FLANGES FOR PARTICLE ACCELERATORS. Droscha, H. Metall; 24: 366-7 (Apr 1970). (In German).

The use of aluminum oxide ceramics as segments for large circular accelerators is discussed. Especially important is the handling of copper-nickel alloy flanges connecting any two consecutive segments. Two methods for hard soldering and welding the metal connections are described and illustrated by diagrams. In addition, two strips of molybdenum are sintered in zig-zag shape into the interior walls of the segments. After completion of the assembly a heating current is sent through the molybdenum strips to achieve a vacuum that is lower by a factor of 10 than those obtainable with metal segments. Moreover, the molybdenum strips serve as conductor for stray electrons and minimize undesirable charges of the conductor wall. (H.B.G.)

29927 MANUFACTURE OF LEAD SHIELDING BRICKS. Ashman, K. L. (Graviner Mfg. Co. Ltd., Gosport, Eng.). 8p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).

See CONF-690331.

The conventional manufacturing methods used for producing lead shielding bricks are outlined and the technique of cold pressing and the advantages of this method of manufacture are described. (auth) (UK)

29928 COMPREHENSIVE SYSTEM OF METRIC LEAD SHIELDING BRICKS. Welsher, R. A. G.; Carter, L. W. (Atomic Energy Research Establishment, Harwell, Eng.). 15p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).

See CONF-690331.

The principal types of bricks in use in the UK and Europe are described and the merits of various brick forms are discussed. A new system of shielding bricks is proposed, based on the best features of existing types. The system is designed in metric units and has a range of five thicknesses from 50 to 250 mm. (auth) (UK)

29929 IMPORTANCE OF STANDARDISATION IN THE LEAD SHIELDING INDUSTRY. Jenkinson, H. A. (W. G. Jenkinson Ltd., Sheffield, Eng.). 15p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).

See CONF-690331.

Existing Standard Specifications applying to the materials and processes used by shield manufacturers are listed and discussed, with particular reference to fabrication techniques and the use of homogeneous lead. The advantages of good international standards are outlined and the problems arising from the imposition by purchasers of unsatisfactory local specifications are emphasized. (auth) (UK)

29930 DEVELOPMENT POTENTIAL OF ZIRCONIUM ALLOYS FOR HIGH-TEMPERATURE APPLICATIONS. Williams, C. D. (Chalk River Nuclear Labs., Ont.). Reactor Technol.: 13: 147-69(Spring 1970).

Reviews of information are included on basis for alloy development, temperature limits for conventional Zr alloys, higher strength Zr alloys, Ti metallurgy as guide for Zr alloy development, and techniques for improving high-temperature Zr alloy properties. (J.R.D.)

29931 PROCESS DEVELOPMENT FOR DIFFUSION WELDING Ti-6Al-4V ALLOY. Rehder, R. J.; Lovell, D. T. (Boeing Co., Seattle). Weld. J. (N. Y.); 49: 213.s-18.s(May 1970).

A low pressure diffusion welding technique for joining Ti-6Al-4V alloy is described. Diffusion welding experiments were carried out in an argon atmosphere under dead-weight compressive loading. Process parameters of time, temperature, pressure, and surface finish were determined. Diffusion welded joints were evaluated by mechanical property testing, metallographic examination, and nondestructive testing methods. Excellent weld quality was obtained at 1800°F with a pressure of 60 psi and a time of 180 min. The optimum surface finish was 15 RHR or better. With these process parameters, joint efficiencies of 100% were obtained. The fatigue properties of the diffusion welded joints approached those of the base metal. NDT methods used were x-ray and ultrasonic A and C scan techniques. Satisfactory NDT results were obtained by both the ultrasonic A and C scan methods. (auth)

Properties Evaluations

Refer also to abstracts 29441, 29466, 31039, and 31094.

29932 (AD-696154) DISLOCATION DAMAGE IN TANTALUM AFTER CYCLIC LOADING. Komem, Yigal; Brandon, David G. (Technion - Israel Inst. of Tech., Haifa. Dept. of Materials Engineering). Aug 1969. Contract F61052-69-C-0042. 28p. (MED-20; AFOSR-69-2766-TR). CFSTI.

The dislocation distribution in tantalum foil after fatigue testing in the region of the yield point was determined quantitatively using thin film electron microscopy. Changes in the measured microstructural parameters as a function of stress level, test temperature, and number of loading cycles was related to a microscopic model of the fatigue process. The model leads to a consistent criterion for fatigue failure based on the gradual growth of impenetrable subboundary groups of immobile dislocations. (USGRDR)

29933 (ANL-7646) CALCULATIONS OF THE THERMODYNAMIC DRIVING FORCE FOR CARBON TRANSPORT IN SODIUM-STEEL SYSTEMS. Natesan, K.; Kassner, T. F. (Argonne National Lab., Ill.). Dec 1969. Contract W-31-109-eng-38. 28p. Dep. CFSTI.

The thermodynamic activity and solubility of carbon in Fe-Cr-Ni alloys were calculated in the temperature range 500 to 800°C by extrapolation of higher-temperature data in the Fe-Cr-C and Fe-Ni-C systems. The compositional range for the alloys included that of an 18-8 austenitic stainless steel. These results were used with phase equilibria information and data for the solubility of carbon in sodium to obtain an equilibrium relationship between the total carbon content in the alloys (austenite carbon + carbide carbon) and carbon concentrations in sodium. The calculations showed that the Fe-Cr-Ni alloys with nominal initial carbon contents may undergo carburization or decarburization depending upon the carbon concentration in sodium and the temperature in the range 500 to 800°C. Computed carbon concentrations in sodium for incipient carbide formation in an 18-8 stainless steel were significantly lower (i.e., below 1 ppM) than carbon concentrations commonly reported (i.e., 15 to 30 ppM) for stainless steel-sodium systems operating at temperatures below 700°C. The phase-equilibria and activity data were used to explain the observed phenomenon of transfer of carbon from austenitic steel to sodium when chromium depletion, due to mass transfer, occurs. In addition, the driving force for carbon transfer from ferritic to austenitic steel under isothermal conditions was calculated. (auth)

29934 (BM-RI-7388) COLUMBIUM ALLOY DEVELOPMENT WITH BORON, HAFNIUM, AND TUNGSTEN. Babitzke, Herbert R.; Oden, L. L.; Kelly, H. J. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Jun 1970. 30p.

The effects of hafnium, tungsten, and boron on the formability, strength, and oxidation resistance of niobium were investigated. The experiment was of factorial design with two replications which called for 72 ingots of 36 basic compositions, weighing 150 grams each. Hafnium, tungsten, and boron were evaluated at 3, 3, and 4 levels, respectively. Values of alloy content are all in atomic percent. The highest strength observed was 29,000 psi at 1,200°C for alloys Nb-15Hf (No. 3), Nb-7.5Hf-5W-2B (No. 14), and Nb-15Hf-5W-2B (No. 15). At 1,200°C, the ternary alloy Nb-15Hf-5W (No. 6) which has shown good properties in previous Bureau of Mines investigations was the most resistant to oxidation. For boron additions, the alloys oxidized more readily with increasing

amounts of this element. The fabricability of the alloys high in boron became increasingly difficult, resulting in an inadequate number of alloys required for a complete statistical analysis for all the tests. As a result of the decrease in ductility, an insufficient quantity of tensile samples was available for a proper analysis for the high-temperature strength data. (auth)

29935 (BMI-1880) INVESTIGATION OF THE INITIATION AND EXTENT OF DUCTILE PIPE RUPTURE PHASE II. Progress Report for January-March 1970. Eiber, Robert J.; Maxey, Willard A.; Duffy, Arthur R.; Atterbury, Thomas J. (Battelle Memorial Inst., Columbus, Ohio). Apr 1970. Contract W-7405-eng-92. 6p. Dep. CFSTI.

Activities in a program to gain information on flaw sizes required to initiate pipe fractures are discussed. Data are also being obtained on the area-opening rate as a function of time and on the extent of fracture. Details of an experiment in which a pipe system is ruptured with subsequent measurements of blowdown behavior are included. (J.R.D.)

29936 (GA-8574(Vol.2)) CESIUM SORPTION IN MATERIALS FOR THERMIONIC CONVERTERS. [PART] II. Yates, M. K.; Fitzpatrick, G. O. (Gulf General Atomic, Inc., San Diego, Calif.). Apr 1970. Contract AT(04-3)-167. 35p. Dep. CFSTI.

Experiments on cesium sorption in materials which serve as high-temperature cesium reservoirs in thermionic converters were conducted. Cesium vapor pressure/sample temperature/sample loading characteristics were measured for two different types of graphite and one sample of porous tungsten. When the data on the graphite samples were compared to some earlier data, it was found that the isotherms for different types of graphite were similar; but the transition between two cesium graphite equilibrium states was better defined in some samples than in others. Hysteresis effects were present in most of the graphite samples but appear to pose no particular problems to the thermionic converter. The data concerning the cesium loading in the porous tungsten sample were obscured by soluble cesium compounds present on the inner oven surfaces. It was determined that the primary sorption mechanism was surface adsorption. Long-term isostere stability tests were run on two graphite samples and one carbon sample. All samples were operated ~800°C at a cesium vapor pressure of ~10 torr. Periodically cesium pressure/sample temperature curves were taken. The required temperature control accuracy for some sorption reservoirs is shown to be approximately one-half that required for a liquid cesium reservoir, and tolerable cesium losses in sorption reservoirs are given for a cesium vapor pressure change. (J.C.W.)

29937 (GEAP-13553) EVALUATION OF THE QUALITY OF SEAMLESS AUSTENITIC STAINLESS STEEL TUBING. Lauritzen, T.; Albanese, J. J.; Berg, G. C.; Gaul, G. G. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Dec 1969. Contract AT(04-3)-189. 44p. Dep. CFSTI.

A compilation of data representing the complete quality assessment of several heats of thin wall seamless tubing is presented. The work was performed on commercial size lots of the five austenitic stainless steel Types-304, -316, -321, -347, and Incoloy-800. The results served to demonstrate the relative capabilities of the several manufacturers to produce high quality seamless tubing and emphasized items in the production and inspection processes that require attention in the eventual large-scale ordering of austenitic stainless steel for canning fast reactor fuel. (auth)

29938 (GEMP-723) FAST BREEDER REACTOR CONTROL, SHIELD, AND REFLECTOR MATERIALS DEVELOPMENT: A SUMMARY REPORT. Van Houten, Robert (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Feb 1970. Contract AT(40-1)-2847. 94p. Dep. CFSTI.

A new diffusion couple test specimen design was developed, evaluated, and found acceptable. The design incorporates a hermetically sealed, thin-walled cylinder of the cladding alloy wafers of varying thicknesses to permit identification of "reservoir" related diffusion-couple effects. The capsule is then maintained at external pressures of as much as 2.8 kg/mm^2 to ensure continuing firm contact of uncontaminated diffusion couple interfaces. Four high-pressure test furnaces, each capable of providing identical pressure-temperature exposures to from 50 to 150 test specimens, were made available to this program. More than 200 diffusion couple test specimens were fabricated and placed on test at test temperatures of 400°C (2.8 kg/mm^2), 500°C (2.8 kg/mm^2), 600°C (2.8 kg/mm^2), 800°C (2.1 kg/mm^2), 1000°C (0.42 and 0.7 kg/mm^2), and 1200°C (0.7 kg/mm^2). Test specimen compositions include: B_4C vs 315 SS, BN vs 316 SS, Ta vs 316 SS, and Ta vs Mo. Preliminary Bn-316 SS diffusion couple test specimens showed excellent stability. Preliminary Ta-Mo diffusion couple test specimens showed excellent stability. Since Ta and Mo have substantially equal thermal coefficients of expansion, Mo-clad Ta is expected to exhibit excellent operational stability. The B_4C-316 SS diffusion couple test data indicate higher reaction rates than were projected from earlier, non-equivalent tests. These test results indicate that the operating time-temperature safety margin is even less than the rather narrow margin previously anticipated. A 1000-hour test of a 3.8 cm diameter Mo clad Ta control rod segment in 550°C sodium flowing (in a 304 SS loop) at 3 meters sec was successfully completed. Post-test inspection showed no change in appearance, weight dimensions or clad to core bonding. It is apparent from the foregoing that while this is a terminal report, it is not the comprehensive quantitative close-out report to which the task workers had committed themselves. Far too many key tests are still in progress to permit any quantitative determinations. There were no test result surprises for the task workers, at least to the time of the drafting of this report, so this task has proved to be largely a demonstration effort. The diffusion couple specimen and test design are novel, but constitute invention, not discovery. The Ta-Ni compound observed by the interface reaction zone deserves further characterization. FBR reflector and shield materials development efforts were proposed, but were effectively prevented by the strong FFTF orientation, and the early termination of this task. The several survey experiments yielded positive results, i.e., both "high-Z" metal hydrides and "high-Z" metals should probably be investigated in the future. (auth)

29939 (N-69-19886) SOLUBILITY AND DIFFUSION OF OXYGEN IN TANTALUM. Parkman, M.; Pape, R.; McRae, R.; Brayton, D.; Reed, L. (Varian Associates, San Carlos, Calif.). Feb 1969. Contract NAS3-7626. 155p. (NASA-CR-1276; APO-68-1101). CFSTI.

The solubility of oxygen in tantalum between 600 and 900°C was determined by using a resistivity technique. Carefully reproduced pulses of oxygen were admitted to a high vacuum quartz tube furnace containing a tantalum wire. During each pulse, oxygen was maintained in contact with the specimen for a standard reproduced time after which the oxygen was pumped out and the resistance measured. A plot of change in resistance from the starting value versus number of oxygen charges resulted in a linear curve followed by one or more parabolic curves. The end of the linear section was interpreted to be the phase boundary. Specimens were analyzed by neutron activation to relate change in resistance to oxygen content. Changes in slope of the resistance versus temperature curve for Ta containing between 0.007 and 0.12% oxygen were found at about 450 and 750°C. An anomaly in the curve of resistance versus temperature for oxygen-doped Ta was found at about 900°C. Both of these effects were found in the 2-phase region and appear to be associated with the oxides. Preliminary solubility data were obtained with niobium and Ta-10W alloy. A trial run was made to test a proposed method of measuring diffusion of oxygen in refractory metals. (auth) (STAR)

29940 (N-70-13794) GENERATION OF LONG TIME CREEP DATA ON REFRACTORY ALLOYS AT ELEVATED TEMPERATURES. Quarterly Report, December 14, 1967-March 27, 1968. Sheffler, K. D.; Steigerwald, E. A. (TRW Equipment Labs., Cleveland, Ohio. Materials Technology Dept.). 14 Apr 1968. Contract NAS3-9439. 71p. (NASA-CR-72431). CFSTI.

The creep resistance of molybdenum-base TZC and TZM and of tantalum-base T-111 and ASTAR 811C is being evaluated in a vacuum environment of less than 10^{-8} torr. Tests from 5000 to 15,000 hours duration were conducted with parameters selected to provide 0.5 to 1.0% total creep. In addition to conventional constant load tests, selected variables were being evaluated with progressively increasing loads. Comparisons of TZC and TZM test results showed the influence of composition and thermal-mechanical processing history on ½% creep life. At higher temperatures and lower stresses the creep resistance of TZC and TZM was comparable in the stress relieved condition. However, in the low temperature and high stress range, a special heat of TZM processed at higher than normal temperatures with a higher than normal carbon content showed the best creep resistance. Several short time tests were conducted on specimens of commerically pure tantalum tubing. T-111 was found to creep at progressively increasing rates under the influence of progressively increasing stress. Various methods for correlating data and for predicting the progressive stress life from static creep tests are discussed. (auth) (STAR)

29941 (N-70-19707) EVALUATION OF TANTALUM FOR MERCURY CONTAINMENT IN THE SNAP-8 BOILER. Derow, H.; Farwell, B. E.; Johnson, E. B.; Kimura, L. A.; Whipple, J. C.;

(and others) (Aerojet-General Corp., Azusa, Calif.). Nov 1969. Contract NAS5-417. 76p. (NASA-CR-72651; AEROJET-3680). CFSTI.

A series of tests were conducted to evaluate tantalum as a material for mercury containment in the SNAP-8 boiler. Mercury corrosion of tantalum was known to be minimal; therefore, the tests were designed to investigate various mechanical designs of the boiler structure containing tantalum. The results of the tests provided information for evaluating the effects on tantalum of air and polyphenyl ether (Mix-4P3E) contaminants in the mercury loop. The test results and their application to the SNAP-8 boiler are described. (auth) (STAR)

29942 (ORNL-TM-2923) CHEMICAL VAPOR DEPOSITION OF VANADIUM AND VANADIUM ALLOYS. A FEASIBILITY STUDY. Federer, J. I. (Oak Ridge National Lab., Tenn.). May 1970. Contract W-7405-eng-26. 20p. Dep. CFSTI.

Vanadium has been vapor-deposited by H_2 reduction of VCl_4 and VF_5 in the temperature range 900 to 1200°C. The efficiency of V deposition from VCl_4 was only about 8% at 900°C, but increased to about 50% at 1100 and 1200°C. Lower chlorides of V always deposited with the metal. Only VF_3 was obtained by hydrogen reduction of VF_5 at 900°C; however, the efficiency of V deposition was about 80% at 1000 and 1100°C, and increased to 100% at 1200°C. Tubular deposits exhibited thickness variations due to depletion of VCl_4 or VF_5 in the gas mixture. The total impurity concentrations of the deposits ranged between 0.6 and 1.2%. The grain structure of the deposits was coarsely columnar and the grains had a strong {110} orientation. Hardness values ranged from 390 to 695 dph depending upon the impurity content. Attempts to deposit Ti and Cr from $TiCl_4$ and $CrCl_4$ for the purpose of preparing alloys with V were generally unsuccessful due to formation of lower chlorides. (auth)

29943 (SC-RR-69-656) MAT2D: A PLANE-STRESS MATERIAL MODEL FOR AN ELASTIC-PLASTIC ANISOTROPIC STRAIN-HARDENING MATERIAL. Barr, G. W.; Young, E. G. (Sandia Labs., Albuquerque, N. Mex.). Jan 1970. 79p. Dep. CFSTI.

The material modeling concept developed to characterize the non-linear strain-hardening behavior of a real material with a suitable combination of elastic-perfectly plastic elements arranged in parallel is used to develop a numerical material model for structural response calculations. The modeling concept is extended to approximate the response of a completely anisotropic material in the elastic range. However, in the plastic range each element of the model is restricted by the Huber-von Mises yield criterion to behave as an isotropic material. This does not imply that the combined plastic response of the model elements is that of an isotropic material. An advantage of modeling the material in this fashion is that an explicit strain-hardening law is not required in the formulation. Special care has been taken to evaluate the flow rules on the yield surface for each elastic-perfectly plastic element to ensure that the stress state remains on the yield surface during plastic deformation. (auth)

29944 (SCL-DR-70-48) COMPUTER DETECTED ERRORS IN THE ASTM X-RAY POWDER DIFFRACTION FILE. Nichols, M. C. (Sandia Corp., Livermore, Calif.). Apr 1970. Contract AT(29-1)-789. 26p. Dep. CFSTI.

Minor deficiencies, inconsistencies, and errors have been discovered on the ASTM X-ray Powder Diffraction File as distributed on magnetic tape. Results indicate that these inaccuracies were derived from: (a) the literature itself, (b) the transfer of data from the literature to the ASTM 3 × 5 file cards, and (c) the transfer of information from the 3 × 5 file cards to the magnetic tape. The errors discovered are included, together with suggestions for both correcting the inconsistencies and omissions found on the 3 × 5 cards and on the magnetic tape version of the file, and for implementing a computer program to detect future inconsistencies and omissions. (auth)

29945 (UCRL-72442) ENGINEERING EVALUATION OF THE STATUS OF UTILIZATION OF BERYLLIUM FROM THE VIEWPOINT OF FRACTURE MECHANICS. Paris, P. C.; Harris, D. O. (California Univ., Livermore. Lawrence Radiation Lab.). 28 Apr 1970. 34p. (CONF-700311-1). Dep. CFSTI.

From Beryllium Conference, Arlington, Va.

The inherent brittleness of beryllium makes it a prime candidate for the utilization of fracture mechanics information for design purposes. One obstacle to the more widespread use of fracture mechanics in the design of beryllium structures is the scarcity of information on its fracture toughness and subcritical flaw growth characteristics. A summary of the available data is presented, which indicates that Be does not compare favorably with other modern structural alloys on the basis of its static fracture properties. However, the limited amount of fatigue crack growth information available indicated that beryllium might have certain advantages in fatigue applications, and that proof testing provided a straightforward means of ensuring the integrity of cyclically loaded beryllium structures. More information on the fatigue crack growth characteristics of beryllium is required to verify this. Additional fracture toughness test results are also required, and the effects of microalloying and thermal history on K_c should be investigated in detail. Information on the stress corrosion characteristics of Be is presently not available. Such tests are certainly warranted, and are required in order to assess the integrity of beryllium structures in various environments. The combined effects of fatigue and stress corrosion also need to be investigated so that fracture mechanics concepts can be applied to the prediction of safe operating stresses and expected lifetimes of beryllium structures operating under such service conditions. (auth)

29946 (WANL-TME-1995) COMPARISON OF THREE ALLOYS FOR CLUSTER SUPPORT APPLICATION IN NERVA REACTORS. McAndrew, J. B. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Feb 1970. 36p. Dep. CFSTI.

Three alloys that have been considered for cooled cluster support components in NERVA reactors are discussed. The alloys are Inconel 718, Waspaloy, and A-286. Each is described in terms of general metallurgy, thermophysical and mechanical properties, and applicable environmental effects. Engineering judgment is employed where specific data needed are not available. The principal conclusion is that Inconel 718 is the best choice for this application. It is also concluded that with the present state of knowledge concerning properties of the alloy in this unique environment, temperature should be limited to 1300°R for stresses such as 50 or 60 ksi. If stresses are not higher than 15 ksi, a temperature of 1500°R should be allowed. (auth)

29947 EFFECT OF STRESS-RELIEVING HEAT TREATMENT ON THE MECHANICAL PROPERTIES OF ORDINARY PRESSURE-VESSEL STEELS. Ulff, C. Jernkontorets Ann.; 154: 53-64(1970). (In Swedish).

On five types of pressure vessel steels the effect of carefully performed stress-relieving heat treatments on tensile properties and transition temperature were studied. Time and temperature are expressed in one parameter, according to a suggestion by Hollomon and Jaffe. (auth) (Sweden)

29948 THE ROLE OF LEAD SHIELDING (PAST, PRESENT, AND FUTURE) AT THE BERKELEY NUCLEAR LABORATORIES OF THE CENTRAL ELECTRICITY GENERATING BOARD. Hadrell, V. J.; Morter, W. F. (Central Electricity Generating Board, Berkeley, Eng.). 6p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).

See CONF-690331.

The initial design and construction of the shielded area in the Berkeley Laboratories are described and the reasoning behind the choice of curved mating surface lead bricks is outlined. More recent thoughts on shielding are described and the whole subject is reviewed and discussed in the light of nearly twenty years' experience at Berkeley. (auth) (UK)

29949 LEAD SHIELDING FOR INDUSTRIAL APPLICATIONS. Veale, F. L. (J. Wardley and Sons Ltd., London). 10p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).

See CONF-690331.

The uses of lead as an essential material for protecting staff using x-rays for nondestructive testing are reviewed. Various designs of shielding are assessed for radiographic, fluoroscopic, and spectroscopic work. Details are given of door design (sliding and side hung), examination cabinets and protection for image intensifiers, observation windows and ventilation ports, problems of shielding equipment with moving belt mechanisms, and protection shielding of large areas. (auth) (UK)

29950 VERSATILITY OF LEAD FOR RADIATION PROTECTION. Newson, E. R. (Lead Fabricators Ltd., Chester, Eng.). 15p. of Lead Shielding and Nuclear Safety Conference. London; Lead Development Association (1969).

See CONF-690331.

Lead can be engineered to satisfy most shielding requirements, and much progress has been made in the production of lead shielding for research establishments, nuclear power stations, medical facilities, transport, and industry; this is described and practical applications are illustrated. An outline of design requirements,

engineering methods, product quality and material specifications is given. Dispersion strengthened lead and one or two shielding design studies in this new material are mentioned. (auth) (UK)

29951 INVESTIGATIONS OF THE BONDING CHARACTERISTICS OF LIQUID INDIUM–THALLIUM AND INDIUM–LEAD ALLOYS BY RESISTIVITY MEASUREMENTS. Predel, Bruno; Sandig, Hartmut (Univ., Muenster, Ger.). Z. Metallk.; 61: 387-94(May 1970). (In German).

In order to determine the nature of bonding in molten indium–thallium and indium–lead alloys the specific electrical resistivity of these alloys was measured in the temperature range from 20 to 500°C. Anomalous increases in resistivity were found in liquid In–40 at.% Tl and In–20 at.% Pb alloys. The anomalies were due to bonding relations which led to the formation of an intermetallic phase in the solid state. (auth)

29952 REGENERATING TUNGSTEN CONTACTS. Serikov, A. P.; Vygoda, R. M. Tr. Irkutsk. Politekh. Inst.; No. 47, 37-42 (1969). (In Russian).

A procedure is recommended for eliminating the flaws in defective tungsten contacts: 1.3 liters of a ferric chloride solution with a concentration of 250 to 290 g/l was used for every 100 grams of rejects. The defective parts and the solution are placed in a 2 liter glass flask and boiled for 1 hour. The solution was then poured off the tungsten contacts and discarded. A new batch of ferric chloride was poured over the residue from the first treatment and again boiled for 1 hour. The solution was poured off and another 100 grams of rejected parts were added to this solution, and the entire contents were boiled for 1 hour. The contacts from which the impurities were thus removed were washed twice in cold water, using 0.1 liter each time. One-half liter of sodium hydroxide solution was poured over the washed contacts and boiled for 0.5 hour. The solution was poured off and kept for treating subsequent batches of tungsten contacts. The contacts were washed in 0.2 liter of hot water and dried on a hot plate. The yield of renovated contacts was 65 to 66% of the initial defective batch. (JPRS)

29953 EFFECT OF A HELIUM ENVIRONMENT ON THE HIGH TEMPERATURE PROPERTIES OF STRUCTURAL MATERIALS. Board, J. (Atomic Power Constructions Ltd., Heston, Eng.). J. Brit. Nucl. Energy Soc.; 9: 101-12(Apr 1970).

The impurity levels in the helium coolant of the Mk III reactor and the data for corrosion of structural materials in impure helium are reviewed. A mode of oxidation consisting of selective oxidation of alloying elements with internal oxidation is suggested for helium containing low levels of impurities. The data on the effect of environment on creep, stress rupture, and fatigue of iron and nickel based alloys are reviewed and it is suggested that with a lack of oxide film, oxygen and nitrogen absorption could result in strengthening of the alloys, but that grain boundary embrittlement might also arise. At high temperatures a mechanism of localized strengthening ahead of cracks which resulted in post-tertiary hardening is invoked. (auth) (UK)

29954 TITANIUM POWDER METALLURGY. Friedman, Gerald I. (Whittaker Corp., West Concord, Mass.). Int. J. Powder Met.; 6: 43-55(Apr 1970).

Titanium alloy powders are described with respect to method of manufacture, physical and chemical properties, response to consolidation operations, and tensile properties in the as-pressed, sintered, and hot-worked conditions. A brief discussion of relative costs is also included. (auth)

29955 TEMPERATURE DEPENDENCE OF THE ELASTIC CONSTANTS OF TANTALUM. Armstrong, D. Alun; Mordike, Barry L. (Univ. of Liverpool). Z. Metallk.; 61: 356-9(May 1970).

The elastic constants of tantalum single crystals were measured over the temperature range –196 to +1200°C. The bulk modulus remained constant until 400°C and then decreased. The largest changes occurred in the shear constants where C_{44} and C′ decreased continuously. (auth)

29956 INFLUENCE OF AN INTERMEDIATE PLASTIC TORSION ON THE FLOW STRESS OF CADMIUM SINGLE CRYSTALS. Ruehlicke, Dieter; Bocek, Michael (Bergakademie, Freiberg, Ger.). Z. Metallk.; 61: 360-8(May 1970). (In German).

The influence of a second kind of deformation (torsion) on the tensile stress-strain curve of tubular cadmium single crystals was investigated. One or several intermediate deformations in torsion with $\Delta\gamma \approx 10^{-3}$ to 10^{-2} led to a reproducible increase of the flow stress $\Delta\tau \approx 1$ to 4 gf/mm² in stage A and a minor increase in the rate of work hardening ϑ_A. The increment in flow stress $\Delta\tau$ was found to depend on orientation amount of strain, temperature, and amount of torsional deformation. (auth)

29957 FATIGUE AT HIGH TEMPERATURE. Symposium Held at San Francisco, Calif., 23–28 June 1968. ASTM Special Technical Publication 459. Philadelphia; American Society for Testing and Materials (1969). 159p. $11.25. (ASTM-STP–459; CONF-680667).

Nine papers were presented at the symposium. A separate abstract was prepared for each of five papers. Papers for which no abstracts were prepared are concerned with fatigue of nickel, low cycle fatigue of Udimet 700 strain-fatigue of steel, and effects of temperature on reversed creep. (J.R.D.)

For abstracts of individual papers see: 29958–29962.

29958 EFFECT OF TEMPERATURE AND STRAIN RATE ON LOW-CYCLE FATIGUE RESISTANCE OF AISI 304, 316, AND 348 STAINLESS STEELS. Berling, J. T. (General Electric Co., Cincinnati); Slot, T. ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 459, 3-30(1969).

From Symposium on Fatigue at High Temperature, San Francisco, Calif. See ASTM-STP–459; CONF-680667.

Results are reported of strain-controlled, low-cycle fatigue experiments conducted on annealed AISI 304, 316, and 348 stainless steels at temperatures of 430, 650, and 816°C with strain rates of approximately 4×10^{-5} s^{-1}. The investigation results generally show that fatigue life measured in terms of sustained loading cycles is affected adversely by the increase in temperature and by the decrease in strain rate. The test results were generated with servo-controlled, hydraulic testing machines using inductively heated hourglass-type specimens. Cyclic stress-strain data obtained from tension tests performed at the same temperatures and strain rates. (auth)

29959 LOW-CYCLE FATIGUE STUDY OF COLUMBIUM ALLOY D-43. Swindeman, R. W. (Oak Ridge National Lab., Tenn.). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 459, 31-41(1969).

From Symposium on Fatigue at High Temperature, San Francisco, Calif. See ASTM-STP–459; CONF-680667.

A machine was developed to study the low-cycle fatigue characteristics of refractory metals in vacuum at high temperatures. Operating capability included temperatures up to 1400°C, loads to 4.45×10^4 N (10 ksi), and frequencies from static to 10 Hz. The machine operated in a push-pull mode and was stroke controlled. To minimize material required for testing, grips were designed to operate at nearly the same temperature as the specimen. A typical specimen geometry was a rod, 76 mm long with a test section 12.7 mm long and 5.18 mm in diameter. A series of tests was performed on a niobium alloy, D-43, at temperatures ranging from 20 to 1204°C and cyclic plastic strains from 0.3 to 4 percent. Data at 20, 871, and 1093°C revealed that D-43 conformed to the Coffin–Manson equation, wherein cycles to failure were related to plastic strain range by a power function. The plastic strain resistance was found to increase with increasing temperature and to exhibit a maximum around 871°C. Up to 1024°C cyclic strain resistance remained better than or equivalent to that at room temperature. Posttest examination of specimen revealed ductile, transgranular failures at all temperatures. (auth)

29960 HIGH-TEMPERATURE LOW-CYCLE FATIGUE EXPERIMENTS ON HASTELLOY X. Carden, A. E.; Slade, T. B. (Univ. of Alabama, University). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 459, 111-29(1969).

From Symposium on Fatigue at High Temperature, San Francisco, Calif. See ASTM-STP–459; CONF-680667.

Low-cycle fatigue behavior of Hastelloy X at elevated temperature is presented. The effects of test temperature, cycle frequency, and stress temperature arrangement were studied with special attention given to the minimum ductility (short-time tension test) at or near 1300°F. Isothermal fatigue data at 800, 1300, 1500, and 1800°F are presented along with strain controlled thermal fatigue data for temperature ranges of 600 to 1800, 800 to 1300, and 1800 to 1300°F. The method of universal slopes can be used to describe the fatigue behavior under elevated isothermal and cyclic thermal fatigue conditions. The thermal fatigue behavior determined from controlled strain tests can be applied to the thermal cycle behavior of bundles of thin tubes joined to a rigid plate. (auth)

29961 SOME MICROSTRUCTURAL AND ALLOYING EFFECTS UPON LOW-CYCLE FATIGUE LIFE OF PRESSURE VESSEL STEELS. DePaul, R. A. (International Nickel Co., Inc., Suffern, N. Y.); Pense, A. W. ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 459, 130-43(1969).

From Symposium on Fatigue at High Temperature, San Francisco, Calif. See ASTM-STP–459; CONF-680667.

Loading by constant deflection reversed bending was applied to Lehigh cantilever fatigue specimens of a plain carbon steel, A-516, and three low-alloy steels, A-302, A-387B, and HY-80. Fatigue life over the 5000 to 100,000 cycle range was investigated at a loading frequency of 200 cpm. The effect of microstructure was observed by comparing the fatigue resistance of specimens of equal tensile strength but different heat treatment histories. Normalized structures proved to be superior to the corresponding spray quenched and tempered conditions when using total strain range as the test parameter. Where similar structures were compared, the 100,000 cycle fatigue life was found to be related to tensile strength. The fatigue resistance of the low-alloy steels was influenced markedly by heat treatment while the plain carbon steel essentially was unaffected. Increased alloy content altered the slope of the fatigue curve such that the plain carbon steel tends to be superior in the 5000 cycle range, while the low-alloy steels excel above the 20,000 cycle region. This results in a grouping of the curves as to steel composition. (auth)

29962 EFFECT OF MICROSTRUCTURE ON THE FATIGUE PROPERTIES OF Ti-6Al-4V BAR. Bartlo, L. J. (Reactive Metals, Inc., Niles, Ohio). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 459, 144-54(1969).

From Symposium on Fatigue at High Temperature, San Francisco, Calif. See ASTM-STP-459; CONF-680667.

Microstructure can have a significant effect on the mechanical properties of titanium alloys. The extent of this effect on the fatigue properties of the Ti-6Al-4V alloy in small diameter bar (0.625 in., 15,875 mm) was studied. Microstructural variations were produced by heat treating from 1550 to 1950°F at 100°F intervals. Three different cooling rates (furnace cooling, air cooling, and water quenching) were employed for each temperature. The room-temperature tensile, smooth, and notch-fatigue properties were evaluated for each thermal condition. Thermal treatments that resulted in grain coarsening were found to lower the fatigue strength of the alloy. Beta quenching resulted in good tensile and fatigue strengths but low tensile ductility. Optimum tensile and fatigue properties occur in material consisting of fine grained alpha-beta structures or in material containing mixtures of fine primary alpha and martensitic alpha. (auth)

29963 THE REACTION OF HYDROGEN CHLORIDE WITH LIQUID SODIUM AND A SODIUM–BARIUM ALLOY. Hobdell, M. R.; Newman, L. (Brookhaven National Lab., Upton, N. Y.). J. Inorg. Nucl. Chem.; 32: 1443-54(May 1970).

The reaction of hydrogen chloride with liquid sodium and sodium containing 4 at. % dissolved barium was studied in the temperature range 100 to 250°C. The reaction took place in two distinct steps: (1) $HCl \rightarrow \frac{1}{2}H_2 + Cl^-$ and (2) $\frac{1}{2}H_2 \rightarrow H^-$, with only the first step involving hydrogen chloride. The effect of barium was to decrease the rate of the hydrogen chloride reaction, but to increase that of hydrogen. However, in both cases molecular hydrogen was produced quantitatively in the gas phase, indicating the absence of net hydrogen uptake in the presence of unreacted hydrogen chloride. The initial reaction of hydrogen chloride with pure sodium exhibited autocatalytic behavior. A reaction scheme was suggested in which the rate-controlling process would be the growth of crystalline sodium chloride on the metal surface. In the presence of barium, however, barium chloride was the predominant product, and the hydrogen chloride reaction rate was found to decrease with time. The rate-controlling process in this case was considered to involve diffusion of hydrogen chloride molecules through pores created in an otherwise protective barium chloride layer. Thus, in each case the overall reaction of hydrogen chloride was controlled by processes involving the solid reaction products. In contrast, under the conditions employed, the kinetics of the hydrogen reaction reflects the nature of the reactants. (auth) (UK)

29964 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elements. April 1970. Band 4, Heft 4. 253 Referate (Register-Nr.950-1414). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. April 1970. Vol. 4, No. 4. 253 Abstracts (Register No. 950-1414)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H. (1970). 138p. (In German and English).

29965 SOLUBILITIES OF METALLIC ELEMENTS IN LIQUID SODIUM. Claar, T. D. (Argonne National Lab., Ill.). Reactor Technol.; 13: 124-46(Spring 1970).

Solubility data have been collected and evaluated for metallic elements in sodium. The reliability of the data for the systems studied has been assessed on the basis of experimental techniques and internal consistency. On the basis of this evaluation, the most reliable data have been used to recommend a solubility–temperature relation for each system that has been well characterized. (auth)

29966 DETERMINATION OF OPTIMUM DIFFUSION WELDING TEMPERATURES FOR Ti-6Al-4V. Kellerer, H. G. (Messerschmitt-Boelkow-Blohn Co., Munich); Milacek, L. H. Weld. J. (N. Y.); 49: 219.s-24.s(May 1970).

It was the purpose of the present study to determine the creep ductility of Ti–6Al–4V at potential diffusion welding temperatures. Standard tensile, tensile creep, and compression creep tests were conducted in the 1600 to 1900°F temperature range. Test atmospheres varied from air atmosphere to inert gas and vacuum. The results of these tests indicated that the creep rate increased with increasing temperature from 1600 to 1750°F and decreased from 1750 to 1900°F. Metallography showed that the grain size increased drastically with increasing temperature, due to the decrease in the amount of primary alpha. It is believed that the creep rate decreases with increasing grain size because of reduced grain boundary sliding. A two step diffusion welding cycle is proposed where initially a temperature around 1750°F provides a maximum surface creep and in the subsequent period the temperature is raised to promote diffusion. (auth)

29967 HEAVY SECTION HP 9Ni-4Co ALLOYS. Munger, Hamnett P. (Republic Steel Corp. Research Center, Cleveland); Gulya, John. Nucl. Eng. Design; 11: 447-56(Apr 1970).

The HP 9–4 alloys are commercially available as plates and weld wire for high strength applications. HP 9–4–20 is usually preferred for heavy sections because of its excellent toughness and fabricability. It is self-tempering, may be welded in the fully heat treated condition, and then may be used without tempering or aging; or if required, may be stress relieved after welding. The TTT diagram indicated that it might be heat treated to 6 in. in thickness and even heavier sections. A 4 in. plate of HP-9–4–20 would have the same load carrying capacity as a 12 in. plate of a 50 ksi yield strength material, with toughness adequate for most commercial applications. A number of examples of fabricated parts are discussed. (auth)

29968 INTERNAL STRESS MEASUREMENTS ON VANADIUM AT ELEVATED TEMPERATURES. Bocek, M.; Schneider, H. (Kernforschungszentrum, Karlsruhe, Ger.). Scr. Met.; 4: 369-74(May 1970).

The internal stresses of recrystallized vanadium were determined at 24 to 1030°C by a decremental unloading technique. The samples were deformed in an Instron type machine under a pressure of less than 5×10^{-6} torr. The internal stresses derived from decremental unloading tests were compatible with theoretical predictions for long range mean internal stresses. (G.M.C.)

29969 HIGH TEMPERATURE INTERNAL FRICTION OF IRON AND IRON–CHROMIUM AND IRON–MOLYBDENUM ALLOYS. Suto, Hajime; Imai, Toru; Uno, Teruo (Tohoku Univ., Sendai). J. Jap. Inst. Metals; 34: 171-7(Feb 1970). (In Japanese).

The internal friction of iron, iron–chromium, and iron–molybdenum alloys was investigated. The results obtained are as follows: The Q^{-1}–T curve of iron had two peaks at about 500 and 630°C. The temperature of the 500°C-peak and the activation energy increased with the carbon content. But the effect of carbon on the temperature for the 630°C-peak was small. Chromium suppressed the 500°C-peak. The temperatures of both peaks did not change remarkably with chromium additions, while the activation energy for the 630°C-peak increased with the chromium content. The temperatures for both peaks, especially the low temperature peak, rose with increasing molybdenum content. The apparent activation energy of the combined peaks increased remarkably with the molybdenum content. It is considered that the low temperature peak corresponds to the atom movement in the grain boundary layer, and that the high temperature peak to the lattice diffusion. Therefore, the measurement of internal friction is useful to understand the high temperature strength of solid solution alloys. (auth)

29970 THERMAL AND PRESSURE STRESSES IN CYLINDRICAL REACTOR PRESSURE VESSELS. Ma, Benjamin M. (Iowa State Univ., Ames). Nucl. Eng. Design; 11: 416-26(Apr 1970).

Transient thermal stresses and steady pressure stresses developed in long, cylindrical pressure vessels of nuclear reactors were determined analytically. The computed results of the tangential thermal and pressure stress distributions in elastic and plastic states of the pressure vessels were obtained and shown by curves. For purpose of comparison, the maximum tangential thermal and pressure stresses for different absorption coefficients (or attenuation parameters) and combined tangential thermal and pressure stresses were also found. The conditions of creep and thermal fatigue for limit design which prevent a fracture failure of the reactor pressure vessels are discussed. (auth)

29971 DETECTION OF FLAWS AND THEIR INFLUENCE ON THE SUPERCONDUCTING CRITICAL CURRENT OF Nb–Zr ALLOY WIRES. Ito, Hideyuki; Tachikawa, Kyoji (National Research Inst. for Metals, Tokyo). J. Jap. Inst. Metals; 34: 296-302(Mar 1970). (In Japanese).

An eddy current method for detecting flaws in fine wires of Nb–Zr alloy and the influence of the flaws on the superconducting critical current I_c of the wires were investigated. The 0.25 mm ϕ wire was sent continuously through a small pick-up coil. The flaws on the wire, cracks, and irregularly deformed cross sections were detected sensitively by the impedance change of the coil oscillated at 300 k Hz. The relation between the depth of artificially introduced cracks and the intensity of the signals was studied. For artificial cracks, a magnetic field angular dependence of I_c was found. I_c showed maxima and minima when the applied field was parallel and perpendicular to a single crack, respectively. The anisotropy of I_c disappeared after annealing at 785°C and seemed to be due to an anisotropy of the sub-structure along the crack. Natural flaws decreased I_c from 10 to 50% and made the field angular dependence of I_c complicated. This seemed to be due to the overlapping influence of several cracks in the natural flaw part. The decrease of I_c caused by the flaws could be recovered considerably by copper-coating. (auth)

29972 REVERSIBLE ROOM-TEMPERATURE ABSORPTION OF LARGE QUANTITIES OF HYDROGEN BY INTERMETALLIC COMPOUNDS. van Vucht, J. H. N.; Kuijpers, F. A.; Bruning, H. C. A. M. Philips Res. Rep.; 25: 133-40(Apr 1970).

Some hexagonal intermetallic compounds of the composition AB_5, where A represents a rare-earth metal and B nickel or cobalt, are reported to absorb and desorb easily large quantities of hydrogen gas under relatively small pressures at room temperature. For some selected compounds, viz. $LaNi_5$ and $SmCo_5$, absorption isotherms and x-ray data are given. Also, data are given for the quasi-binary compounds $La_{1-x}Ce_xNi_5$. The compound $LaNi_5$ forms the hydride $LaNi_5H_{6.7}$ at room temperature under 2.5 atm of hydrogen pressure. Its unit cell expands 25 vol % and seems to retain its hexagonal symmetry. $SmCo_5$ forms the hydride $SmCo_5H_3$ at room temperature under 4.5 atm of hydrogen pressure, while its unit cell expands 10 vol % and becomes orthorhombic. For both hydrides the heat of reaction is found to be about 7 kcal/mole H_2. (auth)

Structure and Phase Studies

Refer also to abstract 30410.

29973 (LA–4354) THE SOLUBILITIES OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. XVI. YTTRIUM. Bowersox, David F. (Los Alamos Scientific Lab., N. Mex.). 5 Jan 1970. Contract W-7405-eng-36. 3p. Dep. CFSTI.

The solubility of yttrium in liquid plutonium increases with temperature from 0.44 wt % at 700°C to 2.55 wt % Y at 990°C. The data fit the equation $\log N_Y = 1.12 - 2.97 \times 10^3\ T^{-1}$, where N_Y is the mole fraction of yttrium in a saturated solution at absolute temperature, T. (auth)

29974 (UCRL-Trans–10452) KINETICS OF THE ISOTHERMAL TRANSFORMATION OF GAMMA SOLID SOLUTIONS OF SOME URANIUM ALLOYS. Kishinevskii, V. B.; Tret'yakov, A. A.; Gomozov, L. I.; Ivanov, O. S. Translated by A. M. A. Mincer for Univ. of California Lawrence Radiation Lab., Livermore, from pp 42-52 of Fiziko-Khimiya Splavov i Tugoplavkikh Soedinenii s Toriem i Uranom, Izdatel'stvo Nauka, Moscow, 1968. 25p. Dep. CFSTI.

The dilatometric method was used to construct diagrams of the isothermal transformation of the γ phase for two ternary alloys (alloys 3 and 4) of uranium with zirconium and niobium and for a binary uranium alloy containing 20 at % of niobium. The resulting C-shaped curves consist of two branches, which indicates that the transformation occurs by different mechanisms at high and low temperatures. The rates of the transformation of the γ phase in the binary uranium alloy containing 20 at % Zr are very high. It has been shown by x-ray diffraction that the decomposition of the alloy with 20 at % of Nb takes place via the formation of a metastable intermediate γ_1 phase with a subsequent formation of a γ_{Nb} phase. The decomposition is heterogeneous in the range of 500 to 600°C. Partial replacement of the niobium by zirconium (alloy 3) leads to the formation of a tetragonal γ^0 phase when the alloy is quenched, and on tempering this phase decomposes by a homogeneous mechanism. As a result of further alloying of the uranium with niobium and zirconium (alloy 4) the quenched specimen contains a γ phase whose decomposition is heterogeneous. (auth)

29975 STUDY OF PRECIPITATION ON URANIUM ALLOY CONTAINING MOLYBDENUM, ALUMINUM, AND CHROMIUM. Bouleau, Maurice; Pouyaud, Paul (CEN de Saclay, Gif-sur-Yvette, France). J. Microscop.; 8: 943-56(1969). (In French).

Precipitation was studied by electron micrography (replicas and thin foils) on a uranium alloy containing molybdenum 0.2%, aluminum 0.15%, chromium 0.05%. The study was made on the material as cast, quenched, and after long time annealing between 500 and 625°C. In the as cast alloy the precipitates have nearly all the same size: 700 to 800 Å; the initial density is 1.2×10^{14}/cm^3. After step quenching the density increase: 1.2×10^{16}/cm^3. Long time annealing cause a coalescence which lowers the density: 8.3×10^{12} and 3.3×10^{12}/cm^3 after 1,000 hours respectively at 550 and 600°C. The second phase has a cubic lattice very similar to UAl_2 with a small contraction, the aluminum has been partly replaced by molybdenum and chromium. (auth)

29976 NUCLEI FORMATION IN THE RECRYSTALLIZATION OF MOLYBDENUM. Guttmann, V. (EURATOM, Petten, Netherlands). J. Less-Common Metals; 21: 51-61(1970). (In German).

A study by transmission electron microscopy was made of the recrystallization of 99.95% pure molybdenum which was 80% deformed by cold rolling. The formation of recrystallization nuclei was observed to occur by the growth of subgrains as well as subgrain regions and by strain induced boundary migration. These mechanisms occurred simultaneously side by side. (auth)

29977 THE BINARY COBALT–INDIUM SYSTEM. Schoebel, Joachim-Dietrich; Stadelmaier, Hans H. (North Carolina State Univ., Raleigh). Z. Metallk.; 61: 342-3(May 1970). (In German).

The binary system cobalt-indium was studied by means of thermal analysis, microscopic, and x-ray diffraction methods. The results were compiled in a phase diagram. The system was characterized by an extended miscibility gap in the liquid state. At lower temperatures, two intermediate compounds were formed peritectically: $CoIn_2$, monoclinic, a = 5.393 Å, b = 17.845 Å, c = 9.218 Å, β = 88.73°, at 550°C, and $CoIn_3$, tetragonal, a = 6.820 Å, c = 3.530 Å, at 490°C. Within the temperature range investigated indium apparently was insoluble in solid cobalt. (auth)

29978 LIQUIDUS SURFACES AND NON-VARIANT EQUILIBRIA IN THE BERYLLIUM–ALUMINIUM–TITANIUM SYSTEM. Aldinger, Fritz; Wellner, Peter (Max-Planck Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 61: 344-9(May 1970). (In German).

In the system beryllium–aluminium–titanium the liquidus surfaces and the invariant equilibria were established by thermal, microscopic and x-ray investigations. In total, 14 four phase reactions were determined, nine of which were transition reactions, two were of peritectic and three of eutectic nature. Two ternary phases existed with the approximate composition TiAlBe and $Ti_5Al_8Be_2$; the first one congruently melted at 1450°C and the later one was formed by a peritectic four phase reaction at 1390°C. Both ternary phases were very brittle, so that no technical construction materials in a wide range of concentration are expected. It was impossible to increase the melting point in the range of the beryllium alloy Lockalloy by alloying with titanium due to the occurrence of the equilibrium α-Be + $TiBe_{12}$ + Al. (auth)

29979 HYDROGEN SEGREGATION IN Ti-6 Al-4V WELDMENTS MADE WITH UNALLOYED TITANIUM FILLER METAL. Williams, D. N.; Koehl, B. G.; Mueller, R. A. (Battelle Memorial Inst., Columbus, Ohio). Weld. J. (N. Y.); 49: 207.s-12.s(May 1970).

Bands of hydrides were observed along the fusion zone: heat-affected zone interface in a Ti–6Al–4V weldment made using unalloyed titanium filler metal and were believed to have been the cause of failure of the weldment. A program was conducted to determine the conditions under which hydride segregation would occur in this type of weldment and to determine the effects of hydride segregation on mechanical properties. During these studies, hydride banding was developed in welds in which the degree of weld dilution was 35%. Hydride banding appeared to be favored more by high hydrogen in the Ti–6Al–4V sheet than in the filler metal. Although obvious hydride segregation was developed, no detrimental effects on mechanical properties were encountered. However, the observation of hydride banding at a weld dilution level as high as 35% was considered to be cause for concern. The severity of banding, and its effect on properties, should increase as the weld dilution level decreases. (auth)

29980 STRUCTURAL EXAMINATION OF WELDED JOINTS OF Zr–2,5 PERCENT Nb. Beghi, G.; Matera, R.; Piatti, G. (CCR–EURATOM, Ispra, Italy). Met. Ital.; 62: 57-67(Feb 1970). (In Italian).

Welded joints on tubes of Zr–2.5% Nb alloy, obtained by electron beam and tungsten inert gas welding, were examined by metallographic and radiocrystallographic techniques and by hardness measurements. The effects of metallurgical transformations induced by the two welding processes on the structure of the melted and the heat affected zone was investigated as well as the thermal stability at the working temperature. (auth)

29981 EFFECTS OF ALLOYING ELEMENT ON SUPERCOOLED A_3 TRANSFORMATION. Izumiyama, Masao; Tsuchiya, Masayuki; Imai, Yunoshin (Tohoku Univ., Sendai). J. Jap. Inst. Metals; 34: 291-5(Mar 1970). (In Japanese).

The cooling rate dependence of A_3 transformation and maximum supercooled A_3 temperatures were investigated on eleven kinds of iron binary alloys by using a rapid cooling apparatus. Maximum supercooled A_3 temperatures of Fe–Mn alloys showed good agreement at higher manganese concentrations with those reported previously but were displaced to lower temperatures at lower manganese concentrations. Extrapolation of the resulting data into zero content of the alloying element led to the maximum supercooled A_3 temperature of about 720°C for pure iron. The maximum supercooled A_3 temperatures of Fe–Cr, Fe–Cu, and Fe–Mo alloys decreased with increasing content of each alloying element and those of Fe–Al, Fe–Ti, and Fe–V alloys increased. In Fe–Co alloys, the maximum supercooled A_3 temperature increased up to about 40% Co and then lowered. Si, W, and Nb had little effects on the maximum supercooled A_3 temperature of iron. Some of the alloying elements had a different effect on the change of A_3 transformation temperature of iron with concentrations in the non-equilibrium condition and in the equilibrium condition. (auth)

29982 PRISMATIC DISLOCATION LOOPS GENERATED IN ANNEALED TANTALUM. Takeyama, Taro; Takahashi, Heishichiro (Hokkaido Univ., Sapporo). J. Jap. Inst. Metals; 34: 307-12(Mar 1970). (In Japanese).

Rows of prismatic dislocation loops in tantalum were observed by means of thin-film transmission electron microscopy. These loops generated from precipitates in the test piece furnace-cooled from 1200°C and showed to lie in the ⟨111⟩ directions. It is considered that these loops are produced by the volume difference between the matrix and precipitates and that the difference results from rapid growth of the precipitates during cooling. These rows consisted of dislocation loops, thus, showing a small tapering with a distance from each precipitate. These dislocation loops were not observed in the as-quenched and aged specimen. The amount of the critical resolved shear stress to move the loop seemed to be consistent with the theory of Bullough and Newman. The value agreed fairly well with that for slip. (auth)

Radiation Effects

29983 (ORO-3912-2) COMPUTER EXPERIMENT STUDIES ON MECHANISMS FOR IRRADIATION INDUCED DEFECT PRODUCTION AND ANNEALING PROCESSES. Progress Report for Period Ending November 30, 1969. Beeler, J. R. Jr. (North Carolina State Univ., Raleigh). Dec 1969. Contract AT(40-1)-3912. 58p. Dep. CFSTI.

Results of work on impurity effects and on void formation and growth in reactor materials are reported. Parallel to these studies, a systematic review of variational and dynamical method computational techniques was initiated. Examination of impurity effects concerned the behavior of carbon atoms near vacancy point defects and near free surfaces (voids). Johnson's atomic interaction functions were used as the basis for this examination. Flow diagrams of defect and impurity atom behavior mode combinations are included. A program to simulate compact, faceted void formation and growth from the stringy aggregates produced in a primary damage state was started. The program is used to analyze the anisotropy of vacancy (defect) diffusion near a void (free surface) and long-range migration effects, as well. It is the prototype program for our high-temperature modification of the ANNEAL Program. Problems in computational technique were uncovered in simulation runs which "converge" to a metastable state rather than to the equilibirum state. All calculations of defect configuration states proceed by first assuming an approximate solution as a "zero-th iteration" or initial estimate, and then amending this initial estimate in a self-consistent manner via some type of iterative process. The two iterative processes most often used are the variational method and the quasi-dynamic method. In the case of simple defects it is not usually necessary to worry about the realism of the zero-th iteration. In the case of complex defects, however, it appears that the capability to define (1) a realistic zero-th iteration strain field and (2) realistic "symmetry" constraints on atom movement is necessary in order to assure convergence to the equilibrium state. (auth)

29984 (SC-RR-70-201) EFFECTS OF NEUTRON IRRADIATION AND HEATING ON THE DIMENSIONAL STABILITY OF STEEL WITH VARYING CHROMIUM CONTENT. Eggert, Gilbert L. (Sandia Labs., Albuquerque, N. Mex.); Meyerson, Melvin R. (National Bureau of Standards, Washington, D. C.). Apr 1970. 19p. Dep. CFSTI.

A series of steel specimens in which the chromium content varied from 0.03 weight percent to 3.06 weight percent was prepared in the laboratory and made into the form of ¼-inch, Grade AA gage blocks. The gage lengths were measured before being held at about 170°C for 115 hours both with and without neutron irradiation. The changes in gage length at five positions on the wringing surfaces of the blocks were measured after these treatments, which were intended to enhance the normally slow-phase transformations which affect volume and shape distortion. Although all the test gages contracted, the shape distortion was most severe in those compositions with less than 0.4 weight percent chromium, and minimal in gages with greater than 1.0 weight percent chromium. The cause of this behavior is explained. (auth)

29985 IRRADIATION EFFECTS IN STRUCTURAL ALLOYS FOR THERMAL AND FAST REACTORS. Symposium Held at San Francisco, Calif., 23–28 June 1968. ASTM Special Technical Publication 457. Philadelphia; American Society for Testing and Materials (1969). 434p. $36.00. (ASTM-STP-457; CONF-680604).

A total of 22 papers was presented at the meeting. A separate abstract was prepared for each of 12 papers. Ten papers have appeared previously in NSA; for abstracts of these see CONF-680604 in the Report Number Index. (G.M.C.)

For abstracts of individual papers see: 29986–29997.

29986 HIGH-TEMPERATURE TENSILE PROPERTIES OF UNIRRADIATED AND THERMAL REACTOR IRRADIATED NIMONIC PE16. Broomfield, G. H. (Atomic Energy Research Establishment, Didcot, Eng.). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 457, 38-66(1969).

From Symposium on Irradiation Effects in Structural Alloys for Thermal and Fast Reactors, San Francisco, Calif. See ASTM-STP-457; CONF-680604.

Nimonic PE16 is an alloy of nickel, iron, chromium, and molybdenum, which was age hardened by precipitation of γ formed with titanium and aluminium. In common with other alloys its high-temperature ductility was reduced after neutron irradiation, presumably by helium from the $^{10}B(n,\alpha)^{7}Li$ reaction. Boron appeared to have dual roles as the source of embrittlement and as augmenter of the alloy's tolerance of helium. Grain refinement of the alloy resulted in little change in the tensile properties until grain sizes were reduced to less than 0.005 mm diameter. The alloy in this condition might have a very high ductility, and the strained structure, together with calculations using the Herring equation, indicated that diffusion strain occurred. Irradiation was embrittling but postirradiation ductility could be higher than usual. The strength of the fine grain material was low. The tensile ductility of the alloy varied widely with strain rate and temperature. When the alloy was unirradiated the ductility trend went through two reversals: as straining time and temperature were increased a peak was observed, followed by a ductility trough and a second ductility increase. The first peak was not observed in tests on irradiated material. The trough occurred under the same test conditions for the unirradiated and irradiated alloy. The conditions for minimum ductility coincided with those for a constant proportion of diffusion strain but not with those for constant stress nor constant strain rate. The cracking behavior either side of the trough was taken to indicate that diffusion relief of stress on carbides was responsible for recovery from the trough with increased straining time and temperature. (auth)

29987 IRRADIATION TESTS OF SEVERAL STEELS FOR REACTOR PRESSURE VESSELS. Hasegawa, M. (Waseda Univ., Tokyo). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 457, 92-112(1969).

From Symposium on Irradiation Effects in Structural Alloys for Thermal and Fast Reactors, San Francisco, Calif. See ASTM-STP-457; CONF-680604.

Trial irradiation tests of pressure vessel steels were conducted on ASTM Specification A302 Grade B, modified A302B with nickel, HY-80, and several other domestic-made low-alloy high strength steels. Specimens were prepared from heavy thick plates up to 250 mm thickness, and experimental plates up to 50 mm thickness, both

of which contained weld zones. Specimens from ASTM Committee E-10 were adopted as a reference material. All specimens were encapsulated in newly designed helium-tight aluminum sheaths. A fusible metal gap was used to control high-temperature irradiation, and to ensure uniformity of neutron flux a rotating retractable rig device was adopted. The irradiation tests were carried out in the BR-2 reactor. In almost all cases fast neutron fluxes ranged from 3 to 4×10^{19} n/cm^2 (over 1 MeV), and irradiation temperatures were 75 and 260°C. Postirradiation tests included tension, impact, hardness, and microstructure examinations, but evaluation of the results was based mainly on the transition curves derived from standard Charpy impact tests. The effects of smelting practice were noticeable; the L-D process and the aluminum-nitride treatment, in particular, showed good effects on the reduction of irradiation sensitivity. The irradiation sensitivity of thick plates was largely influenced by thickness, that is, mass effect—and heat treatment. In general, weld zones were somewhat more sensitive than the parent metal. The shift of transition temperature (ΔTr) of the ASTM reference steel fell into the range of the trend band established by studies, but most specimens showed much less sensitivity than the reference steel as measured by ΔTr except for long-time heated experimental specimens. (auth)

29988 INITIAL ASSESSMENTS OF NOTCH DUCTILITY BEHAVIOR OF A533 PRESSURE VESSEL STEEL WITH NEUTRON IRRADIATION. Hawthorne, J. Russell; Potapov, Uldis (Naval Research Lab., Washington, D. C.). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 457, 113-34(1969).

From Symposium on Irradiation Effects in Structural Alloys for Thermal and Fast Reactors, San Francisco, Calif. See ASTM-STP-457; CONF-680604.

Exploratory assessments were made of the Charpy-V notch ductility characteristics of heavy section A533-B and A533-C steel plate and submerged arc weldments following neutron irradiation at 550 F. The experimental evaluations were performed largely with commercial production materials and included comparisons of materials in both Class 1 and Class 2 strength ranges. Postirradiation notch ductility properties of one 5¾-in. A533-B Class 1 electroslag weldment were also developed. Assessments made of relative irradiation performance were assisted by a compilation of recent information on the response of the ASTM reference A302-B steel plate. Major findings included the observation of significant variability in radiation embrittlement sensitivity of A533-B and A533-C steel, wherein the sensitivity level of plate and weld metal in some cases exceeded that of the ASTM reference plate. High radiation embrittlement sensitivity was noted for both submerged arc weld deposits examined; however, the data suggested that the performance of the weld heat-affected zone paralleled that of the parent plate. High embrittlement sensitivity was also noted for the electroslag weld deposit in contrast to markedly low sensitivity of the weldment parent plate. The notch ductility behavior of A533 plate and weld metal under 550 F irradiation was not found influenced measurably by either the strength class (Class 1 or 2) or by the particular grade of steel (Grade B or C). Similarly, there were no marked variations in irradiation response through the thickness of plate or weld metals, or between RW (longitudinal) versus WR (transverse) orientations in cross-rolled plate. The study demonstrated that the radiation embrittlement resistance of commercially produced A533 steel plate and weld deposits could be predicted in part from their individual chemical compositions. High copper and phosphorus contents generally signified high sensitivity to 550°F radioinduced changes in notch ductility characteristics. (auth)

29989 NOTCH DUCTILITY, TENSILE, AND NEUTRON SPECTRUM ANALYSES OF PM-2A REACTOR PRESSURE VESSEL. Serpan, C. Z.; Watson, H. E. (Naval Research Lab., Washington, D. C.). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 457, 135-55(1969).

From Symposium on Irradiation Effects in Structural Alloys for Thermal and Fast Reactors, San Francisco, Calif. See ASTM-STP-457; CONF-680604.

Following the pressurization-to-failure testing of the PM-2A reactor pressure vessel, several sections of steel were removed from the vessel wall in a region adjacent to the artificial defect. Charpy V-notch and tension test specimens machined from one of these sections were evaluated. The irradiated-condition 30 ft-lb transition temperatures for the ¼ thickness (nearest to the core) and ¾ thickness locations in the vessel wall were +115 and +55 F, respectively, for measured fission spectrum fluences of 7.3 and 4.0×10^{18} n/cm^2 >1 MeV. The ¼ thickness properties and fluence most nearly represented those at the tip of the artificial defect. The 0.2 percent yield strength for the ¼ thickness location was 97,620 psi at −20 F (failure temperature) and 92,200 psi at +72 F (temperature at time of acid sharpening treatment of artificial defect). Significant uniform elongation, reduction of area, and elongation in 1 in. were retained by the steel. An assessment of the stress, temperature, and flaw size conditions for the PM-2A failure, as indexed by the irradiated-condition mechanical properties, indicates that the failure is in agreement with the generalized fracture analysis diagram. (auth)

29990 IRRADIATION EFFECTS IN PRESSURE VESSEL MATERIALS FOR STEAM-COOLED FAST REACTORS. Grounes, M.; Lindhagen, P. (Aktiebolaget Atomenergie, Studsvik, Sweden). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 457, 156-79(1969).

From Symposium on Irradiation Effects in Structural Alloys for Thermal and Fast Reactors, San Francisco, Calif. See ASTM-STP-457; CONF-680604.

Steam-cooled fast reactor pressure vessels must withstand high pressures (130 to 230 atm) and high neutron doses, for example, 5×10^{20} n/cm^2 (>1 MeV). Two new steels were investigated, a 16 Cr-5 Ni-1 Mo steel (Avesta 248 SV) and a 13 Cr-6 Ni-1.5 Mo steel (Bofors 2 RM0). Their tensile strength was above 70 kg/mm^2 at 300°C. The steels were unusually tough at low temperatures, and there was no sharp brittle-to-ductile transition. Various properties of the steels are described. Impact and tension specimens were irradiated in two thermal reactors at 60 to 550°C. After 3.2×10^{19} n/cm^2 (>1 MeV) at 265°C, the temperature at 4.2 kg-m impact energy was increased 100°C to −90°C. Tension tests showed small decrease or an increase in ductility because of irradiation. To draw conclusions from these experiments the differences in neutron spectra between the materials testing reactors and the fast reactor vessel had to be taken into account. This problem is discussed for two types of damage: displacement damage and transmutation damage. In the former case, an attempt is made to use different damage theories for an engineering type of estimate of the maximum difference between irradiation effects in the two types of spectra. In the latter case, an analysis of the transmutation reactions is made. (auth)

29991 EFFECTS OF INTERSTITIAL ELEMENTS ON RADIATION HARDENING IN MILD STEELS. Little, E. A.; Harries, D. R. (Atomic Energy Research Establishment, Harwell, Eng.). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 457, 215-41(1969).

From Symposium on Irradiation Effects in Structural Alloys for Thermal and Fast Reactors, San Francisco, Calif. See ASTM-STP-457; CONF-680604.

Neutron irradiation produced greater increases in room-temperature tensile lower yield stress of annealed silicon killed mild steel than in that of annealed aluminum grain size controlled steel. This difference in behavior was due primarily to the presence of free nitrogen in the silicon killed steel. Preliminary results suggest that free carbon in the steels does not enhance the radiation hardening. The amount of nitrogen in solution in the silicon killed mild steel was progressively reduced with increasing neutron dose. Furthermore, the nitrogen returned to solution and the radiation hardening was recovered on annealing at temperatures in the range 300 to 400°C. These effects were attributed to the nitrogen and the irradiation-induced point defects forming complexes that restricted dislocation movement and thereby increased the radiation hardening. Neutron irradiation had a marked effect on the dynamic strain aging behavior and the temperature dependence of the yield and flow stresses of the annealed silicon killed mild steel in the range 90 to 250°C. The results are explained on the basis of a strain rate effect, assuming that channeling is the operative deformation mechanism in the irradiated steel, and thermal activation of the radiation damage. (auth)

29992 RADIATION HARDENING AND EMBRITTLEMENT IN A REACTOR PRESSURE VESSEL STEEL. Wechsler, M. S.; Berggren, R. G.; Hinkle, N. E.; Stelzman, W. J. (Oak Ridge National Lab., Tenn.). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 457, 242-60(1969).

From Symposium on Irradiation Effects in Structural Alloys for Thermal and Fast Reactors, San Francisco, Calif. See ASTM-STP-457; CONF-680604.

The relationship between the increase in tensile yield stress (YS) and the increase in the ductile-brittle transition temperature (DBTT) upon irradiation was studied for ASTM A 212-65 Grade B pressure vessel steel. Smooth tension specimens and Charpy V-notch impact specimens were irradiated under the same conditons of 60°C irradiation temperature of 1×10^{19} neutrons/cm^2 (E > 1 MeV) fluence. The tension tests were carried out at temperatures from 20 to 473°K at two strain rates. The YS increased rapidly with decreasing test temperature, but the radiation-produced increment in YS was largely independent of test temperature. The impact specimens also were tested as a function of temperature and the increase in DBTT was determined based on absorbed en-

ergy and fracture appearance. To correlate the changes in YS and DBTT upon irradiation, strain-rate and triaxiality corrections were applied to the tensile yield stresses to approximate the corresponding stresses at the root of the notch of the impact specimens. The results of the tension and impact tests were found to be consistent, based on a critical cleavage stress deduced from the tension tests. No evidence for a decrease in the critical cleavage stress upon irradiation was noted. The conclusion is that the radiation embrittlement is largely a consequence of radiation hardening and not a change in fracture properties as such. (auth)

29993 DEVELOPMENT OF A TITANIUM-MODIFIED HASTELLOY N WITH IMPROVED RESISTANCE TO RADIATION DAMAGE. McCoy, H. E.; Weir, J. R. (Oak Ridge National Lab., Tenn.). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 457, 290-311(1969).

From Symposium on Irradiation Effects in Structural Alloys for Thermal and Fast Reactors, San Francisco, Calif. See ASTM-STP-457; CONF-680604.

Studies of the effects of neutron irradiation on the high-temperature mechanical properties of Hastelloy N showed generally that the creep-rupture life and ductility were reduced. The ductility was a strong function of the strain rate and showed a minimum at a minimum creep rate of about 0.1% per hour. The resistance of this material to radiation damage could be enhanced greatly by adding titanium. Laboratory and commercial melts showed that the postirradiation creep-rupture ductility and strength rise sharply as the titanium content was increased above 0.3 wt %. Although the degree of improvement was still rising as the titanium level was increased to 1% most of the studies were carried out on an alloy with about 0.5 wt % titanium. Postirradiation creep-rupture tests at 650°C on specimens irradiated to a thermal fluence of 5×10^{20} neutrons cm^2 indicated that a ductility minimum still exists as a function of strain rate. However, the minimum strain is 3 to 5% as compared with 0.5% for the standard alloy. In-reactor creep-rupture tests were also run and the same improved properties were indicated. Studies of the titanium-modified alloy have not progressed sufficiently to pinpoint the exact role of titanium in bringing about the improved properties. However, several observations were made which allow some postulations to be made at this time. (auth)

29994 EFFECTS OF YTTRIUM ON THE STRUCTURE AND POST-IRRADIATION TENSILE PROPERTIES OF AN IRON–CHROMIUM–ALUMINUM ALLOY. Roberts, A. C. (Atomic Energy Research Establishment, Harwell, Eng.); Harries, D. R.; Arkell, D. R.; Dewey, M. A. P.; Hughes, J. D. H. ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 457, 313-28(1969).

From Symposium on Irradiation Effects in Structural Alloys for Thermal and Fast Reactors, San Francisco, Calif. See ASTM-STP-457; CONF-680604.

The effects of 0.86 percent yttrium on the structure and high temperature tensile properties of unirradiated and thermal reactor irradiated Fe-15Cr-4Al ferritic steel were investigated. Yttrium reduced the grain coarsening tendencies of this alloy; the yttrium was present mainly as YFe_3 precipitates within the grains and generally aligned in the direction of rolling. Autoradiographic examination showed that the boron was concentrated at the grain boundaries of the yttrium free alloy, while the boron was primarily associated with the YFe_3 phase in the 0.86 percent yttrium alloy. The tensile ductilities of the 0 percent yttrium alloy at temperatures ranging from 700 to 950°C were markedly reduced after irradiation at 50 or 650°C; the magnitude of the embrittlement was somewhat greater after irradiation at the higher temperature. This irradiation induced embrittlement was associated with failure along the grain boundaries. There were no significant reductions in the high-temperature ductilities of the 0.86 percent yttrium alloy after irradiation. Optical and thin film electron microscope examinations suggested that the mechanism of the irradiation induced embrittlement in the 0 percent yttrium alloy was similar to that proposed for austenitic steels, namely, the stress induced growth of grain boundary helium bubbles produced as a result of the $^{10}B(n,\alpha)^7Li$ reaction. The absence of a high-temperature irradiation embrittlement effect in the 0.86 percent yttrium alloy was considered to be primarily because of the association of most of the boron with the YFe_3 phase and, hence, the retention of the helium within the grains. (auth)

29995 DEVELOPMENT OF FUEL CLADDING FOR FAST REACTORS. Cunningham, G. W. (Atomic Energy Commission, Washington, D. C.). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 457, 329-35(1969).

From Symposium on Irradiation Effects in Structural Alloys for Thermal and Fast Reactors, San Francisco, Calif. See ASTM-STP-457; CONF-680604.

An extensive program directed toward the development of thin-wall small diameter tubing that can remain in the fast reactor environment for periods up to three years at temperatures to 800°C, strains to 3 percent, and a total fluence of 3×10^{23} nvt is being conducted. Austenitic stainless steels were selected as the reference material with vanadium alloys as the primary backup material. Emphasis was placed upon quality assurance for commercially produced stainless tubing. The experimental program also included extensive work on sodium corrosion and radiation damage. (auth)

29996 HIGH-TEMPERATURE EMBRITTLEMENT OF AISI TYPE 316 AUSTENITIC STAINLESS STEELS AFTER IRRADIATION. Weisz, M.; Malkin, J.; Erler, J.; Andre, J. P. (CEN, Saclay, France). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 457, 352-70(1969).

From Symposium on Irradiation Effects in Structural Alloys for Thermal and Fast Reactors, San Francisco, Calif. See ASTM-STP-457; CONF-680604.

Potential cladding materials for fast reactor fuel elements, i.e., austenitic stainless steels and precipitation-hardened nickel alloys, were irradiated to a dose of 3×10^{21} nvt (E > 1 MeV) in different thermal reactors and to a dose of 1.6×10^{22} nvt (total dose) in a fast reactor. The irradiation temperature was about 700°C in thermal reactors and about 500 to 600°C in a fast reactor. After irradiation, tension tests and uniaxial stress rupture tests were performed at temperatures in the 600 to 800°C range. For all alloys, high-temperature tests after irradiation showed a more or less pronounced embrittlement, not recoverable by any post-irradiation annealing. This embrittlement was associated with intergranular wedge-type cracks initiating at triple points. For a given alloy, at a given temperature, the lower the rate of deformation, the more pronounced the embrittlement. For Type 316 austenitic steels, the radioinduced hardening was low and disappeared at a maximum temperature of 800°C. The embrittlement was associated with a decrease in the nonuniform part of the elongation in tension tests and with a decrease in the elongation and duration in the tertiary stage of stress-rupture tests. Two types of factors were studied: those concerning the structural parameters-grain size, precipitation, prestraining, and chemical composition; and those concerning the actual conditions of irradiation. (auth)

29997 COMPARISON OF RADIATION DAMAGE STUDIES AND FUEL CLADDING PERFORMANCE FOR INCOLOY-800. Comprelli, F. A. (General Electric Co., Sunnyvale, Calif.); Busboom, H. J.; Spalaris, C. N. Contract AT(04-3)-189. ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 457, 400-13(1969).

From Symposium on Irradiation Effects in Structural Alloys for Thermal and Fast Reactors, San Francisco, Calif. See ASTM-STP-457; CONF-680604.

Postirradiation tension and burst tests were performed at 593 and 704°C on materials from various heats of Incoloy-800 to establish the effect of irradiation on short-term mechanical properties for fast fluences to 6.25×10^{21} n/cm^2. Two types of tension specimens were tested: precut sheet specimens that were prepared prior to irradiation, and fuel clad specimens prepared from irradiated Mark II EVESR fuel rods. At the highest fluences, uniform elongations of 1.5 to 2.0 percent were measured for precut specimens. The uniform elongation was found to be dependent upon the strain rate at which the specimen was tested. Comparable fuel cladding properties at this fluence were not yet available. At a fast fluence of 5.7×10^{20} n/cm^2, precut specimens exhibited uniform elongations of 11.5 to 16.8 percent whereas fuel clad exhibited 2.6 to 6.0 percent for similar fluence and test conditions. It was concluded that the greater degradation of ductility in fuel cladding specimens was associated with both nonuniform (and often higher) temperature and plastic strain experienced during the irradiation period. (auth)

29998 MECHANICAL PROPERTY AND NEUTRON SPECTRAL ANALYSES OF THE BIG ROCK POINT REACTOR PRESSURE VESSEL. Serpan, Charles Z. Jr.; Watson, Henry E. (Naval Research Lab., Washington, D. C.). Nucl. Eng. Design.; 11: 393-415(Apr 1970).

The mechanical property changes in Charpy-V and tensile specimens were determined as a result of irradiation at 585°F in accelerated, vessel wall, and thermal control exposure locations of the Big Rock Point Reactor. The weld metal displayed a higher rate of increase than either the base or heat affected zone material; nevertheless, because of its −70°F initial transition temperature, the maximum final transition temperature that could be projected for the weld metal was only 180°F, and this included 15°F derived from measurements of thermal aging effects. Both the yield and tensile strengths increased as a result of the irradiation, but did not approach coincidence; the retention of tensile ductility thus suggested was reinforced by the reduction in

area values, none of which fell below 44%. The 0.2% yield strength increase measured from a three year exposure was significantly higher than the trend exhibited by shorter irradiations at 16 to 24 times higher flux rates. This suggests an enhanced effect of lower flux rates over long time periods; this salient effect on the yield strength was not, however, also displayed by the Charpy-V results. Theoretical neutron spectra for the Big Rock Point surveillance locations showed the neutron energy distributions to be significantly different from a fission spectrum. The calculation permitted adjustments in the flux values to reflect these differences and provided the means to extrapolate a fluence for the 40 year full power service limit of the reactor. This was projected to be 8.1×10^{19} n/cm^2 > 0.5 MeV. The service-limit fluence was also projected by establishing a ratio of a specific fluence with its corresponding MWh and the MWh in 40 years at full power. The fluence thus derived was also 8.1×10^{19} n/cm^2 > 0.5 MeV. The favorable pressure vessel analysis suggested by these data should be valid if the power level of the reactor is not substantially increased and if the neutron spectrum conditions are not detrimentally altered. (auth)

29999 MECHANICAL PROPERTIES OF IRRADIATED FUEL ELEMENTS. Vorob'ev, M. A.; Golovchenko, Yu. M.; Davidenko, A. S.; Bychkov, B. A. At. Energ. (USSR); 28: 107-11(Feb 1970). (In Russian).

Mechanical properties of uranium cores of rod-shaped fuel elements irradiated up to 0.04 to 0.4% burnup at temperatures in the range 120 to 500°C (compression, tension and fatigue tests) were studied. Changes of strength and ductility of uranium depended on the burnup level and irradiation temperature. The lowest mechanical strength was observed at temperatures in the range from 250 to 350°C. It was also shown that irradiated uranium had significant ductility under compression tests as compared with tension tests. The presented results can be used to design fuel elements with metal uranium cores. (auth)

30000 TRENDS IN CHARPY-V SHELF ENERGY DEGRADATION AND YIELD STRENGTH INCREASE OF NEUTRON-EMBRITTLED PRESSURE VESSEL STEELS. Hawthorne, J. Russell (Naval Research Lab., Washington, D. C.). Nucl. Eng. Design; 11: 427-46(Apr 1970).

Charpy-V shelf energy degradation and yield strength increase were examined for three neutron-irradiated pressure vessel steel compositions: A302-B, A533, and A543. The effects of radiation exposure at low temperature (<300°F) and at elevated temperature (550 to 740°F) on overall notch ductility are documented and compared. Summary plots showing the simultaneous degradation in shelf energy and increase of yield strength levels broadly illustrate the progressive change from ductile fracture performance to relatively brittle characteristics. Data for all three steel types suggested a common pattern of properties behavior. Three stages of the shelf level versus yield strength change were indicated with progressive neutron exposure at <300°F. Data patterns for strong (longitudinal) versus weak (transverse) test orientations of thick section plate implied strong trend similarities. Properties modified by progressive radiation exposure at 550°F were interpreted as following the same damage path described by <300°F irradiation. The much slower pace of properties change with elevated temperature exposure was readily identified by trend line presentations. Observations showed that A533 plate and weld metals (Grades B and C, Classes 1 and 2) had greater toughness retention than the ASTM A302-B reference heat (6-in. plate) after 550°F radiation. Results for a single reference heat of A543 Class 1, 8-in. plate demonstrated that a lower initial brittle/ductile transition temperature in itself may not fully eliminate the general problem of providing sufficient notch ductility to allow for radiation embrittlement in service. Studies of A543 steel also revealed that temper embrittlement introducing during fabrication was not a strong influence on subsequent irradiation-induced changes in Charpy-V notch ductility at exposure temperatures up to 750°F. (auth)

30001 RADIOINDUCED HARDNESS CHANGES OF VARIOUSLY DEFORMED ALUMINUM SAMPLES. Tweer-Schreiner, Ilse; Lintner, Karl. Oesterr. Akad. Wiss. Math.-Naturwiss. Kl., Anz.; 105: 232-6(1968). (In German).

The effect of cold working of Al before α irradiation was investigated. The results showed that cold working was essential for the irradiation to affect the hardness, which could be traced back to the interaction of impurities with the radioinduced defects. Very small and very high degrees of rolling caused a sharp alteration of the damage rate. (J.S.R.)

Ceramics and Cermets

Refer also to abstracts 29907 and 29924.

Preparation and Fabrication

Refer also to abstracts 29238, 29239, 29420, 29920–29922, and 31074.

30002 (CONF-700502) SYMPOSIUM ON SOL-GEL PROCESSES AND REACTOR FUEL CYCLES, GATLINBURG, TENNESSEE, MAY 4–7, 1970. (Oak Ridge National Lab., Tenn.). May 1970. 584p. Dep. CFSTI.

The conference proceedings are divided into 7 sections and include 38 papers. The sections are titled: Reactor Fuel Cycles, Fuel Element and Process Design Using Sol-Gel Systems, Sol-Gel Processes for Fuel Preparation, Fabrication Processes for Sol-Gel Fuels, Performance of Sol-Gel Fuels, Fundamental Studies, and Supplement. A separate abstract was prepared for each of the 38 papers. (B.L.M.)

For abstracts of individual papers see: 29176, 29238–29240, 29920, 29921, 30003–30024, 30049–30052, 31065–31067, and 31078–31080.

30003 (CONF-700502–, pp 74-84) PENETRATING RADIATION DOSE RATES AND SHIELD REQUIREMENTS IN FABRICATION OF FUELS CONTAINING ^{233}U AND HIGH EXPOSURE PLUTONIUM. Bell, M. J.; Nichols, J. P. (Oak Ridge National Lab., Tenn.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Calculations were made of the neutron and γ radiation produced by recycle ^{233}U and high exposure Pu fuels. This information, together with data that have been generated in the preparation of $^{233}UO_2$–ThO_2 fuels, has been used to estimate the radiation dose rates and shielding requirements to be expected in the preparation and fabrication of recycle fuels for LMFBR's, LWR's, and HTGR's. While relatively small scale production is possible in lightly shielded glove box lines, these results indicate that large scale production plants will probably utilize predominantly remote operation and shields that have attenuation coefficients comparable to 2 to 3 ft of normal concrete. (auth)

30004 (CONF-700502–, pp 100-12) SOL-GEL PROCESSES FOR PuO_2 AND UO_2–PuO_2. Lloyd, M. H.; McDuffee, W. T.; Tallent, O. K.; Morse, L. E.; Haire, R. G. (Oak Ridge National Lab., Tenn.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

The sol-gel process used at Oak Ridge National Laboratory to prepare PuO_2 sols and oxide microspheres from PuO_2 sols and mixed UO_2–PuO_2 sols is described. Kilogram quantities of dense microspheres were prepared to provide nuclear fuel specimens for irradiation tests. The sols used in this program were prepared by precipitation-peptization techniques. A solvent extraction process for preparing plutonia sols (APEX) was developed, and these sols were mixed with urania sols prepared by solvent extraction (CUSP) and formed into dense oxide microspheres (80% UO_2–20% PuO_2) in numerous small scale experiments. When plutonia sols are mixed with urania sols, a colloidal instability develops. The techniques employed, which adequately control mixed sol stability during microsphere preparation, are described. Although satisfactory microspheres can be made in small scale tests, additional development is required to optimize the process and to use it in routine production on a larger scale. (auth)

30005 (CONF-700502–, pp 123-36) SOL-GEL PROCESSES FOR URANIA–THORIA FUELS. Bond, W. D.; Finney, B. C.; Haas, P. A.; Haws, C. C.; Parrott, J. R. (Oak Ridge National Lab., Tenn.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

The preparation of 32 kg of high density 75% ThO_2–25% $^{233}UO_2$ microspheres was carried out in semiremote operations in which ThO_2–UO_2 sols were prepared by amine extraction and converted to product microspheres. The radiation from ^{233}U and its associated ^{232}U (6 ppM) impurity had no deleterious effects on the sol-gel process steps. The preparation of 81% ThO_2–19% UO_2 microspheres was conducted in a continuous, engineering-scale demonstration at a rate of 10 kg (Th + U)/day, and ~120 kg of ThO_2–UO_2 gel spheres were produced. Sol preparation by the amine extraction process was routine and reproducible, and 1.6 M ThO_2–UO_2 sol product was produced in 99.5% yield based on the metal nitrate feed. A 100.2% material balance was attained. Microsphere forming results showed that up to 95% yields (based on sol feed) are attainable when producing 250- to 450-μ-diam spheres (calcined) using multiple two-fluid nozzles and gelation of the sol droplets in 2-ethyl-1-hexanol (2EH). The material balance was 99.5%. Operation of batch, fixed-bed gel sphere dryers of 20 kg capacity, previously used for drying ThO_2 gel spheres, was unsuccessful with

ThO_2-UO_3 spheres because of uncontrollable, deleterious temperature excursions. After installation of an adequately designed dryer, 20 kg batches of the ThO_2-UO_3 gel spheres were dried successfully in the required 48 hr turnaround time. Further development and testing of drying and firing equipment was also indicated. No problems were encountered in firing 10 kg batches of dried gel spheres in a fixed-bed, but further work must be done in order to determine the bed depth or size limits to prevent possible interparticle sintering and for satisfactory heat transfer. (auth)

30006 (CONF-700502–, pp 137-49) GEL PROCESS DEVELOPMENT IN THE UNITED KINGDOM. Hardy, C. J.; Lane, E. S. (Atomic Energy Research Establishment, Harwell (England)).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Sol-gel and gel-precipitation processes were developed in parallel in recent years in the United Kingdom for the preparation of spheres of metal oxides and carbides of controlled composition, size, and density. The processes and equipment are illustrated for UO_2 spheres of 200 to 800μ diameter and 60 to 98% density, and ZrO_2-UO_2 spheres of 100 to 300μ diameter and 40 to 98% density. The control of density was examined in detail and two methods were developed, firstly, calcination in an oxidizing followed by a reducing atmosphere, and secondly, the addition and burn-out of carbon. Equipment was operated on the 0.5 kg/hr scale to produce UO_2 spheres of controlled density and about 800μ diameter. (auth)

30007 (CONF-700502–, pp 150-63) LABORATORY STUDIES AND PILOT PLANT DEVELOPMENT OF SOL-GEL PROCESSES IN ITALY. Gallone, S. (Agip Nucleare, Milan (Italy)); Schileo, G.; Zifferero, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Early work on sol-gel in Italy dates back from 1963: two different processes were independently developed at CNEN and at SNAM Progetti SpA. Both are suitable for the fabrication of Th and U oxides and mixed oxides. CNEN process has a typical sol-gel approach whereas SNAM's can be more properly defined a gel-supported precipitation process. In 1966 SNAM Progetti and CNEN decided to work jointly on the application of the gel supported precipitation route to the production of mixed urania–plutonia microspheres. Today most of the activity carried out in Italy is connected with the gel supported precipitation processes. This includes: pilot plants operation, irradiation testing, and preliminary economic evaluation. (auth)

30008 (CONF-700502–, pp 164-77) SOL-GEL PROCESSES FOR THE PREPARATION OF U–Pu–CARBIDE FUELS. Bischoff, K.; Scherer, V.; Schumacher, H. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)).

From Symposium on Sol-Gel Processes and Fuel Cycles.

A review is given of the work done on sol-gel processes in Switzerland within the scope of a research and development program on fast reactor fuels. One objective of the program is the application of sol-gel processes to carbide fuel production. Some of the special problems connected with the preparation of U–Pu monocarbides, including addition of carbon to the sols, gelation of carbon-containing sols, and carbothermic reduction, are reviewed briefly. A newly developed method of gelation, "freeze-gelation," is described. Theoretical studies and thermodynamic calculations on carbothermic reduction of sol-gel materials are discussed. (auth)

30009 (CONF-700502–, pp 178-89) SOL-GEL PROCESS DEVELOPMENT IN JAPAN. Nakamura, Y.; Tsunoda, N.; Suzuki, S. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Sol-gel process for the preparation of dense and coarse UO_2 and PuO_2-UO_2 shards that can be used for vibratory compaction was developed in Japan. The process established gave products with satisfactory characteristics for the vibratory compacted reactor fuels. A series of capsule irradiation testings was performed, and also an assembly of 3 × 3 fuels was successfully irradiated in Halden Boiling Water Reactor. Post-irradiation testings of these irradiated fuels are proceeding now, and some results have shown that the sol-gel fuels have promising performance. About 20 Kg of 3.1% PuO_2-UO_2 sol-gel fuel was prepared without any trouble in the process operation. (auth)

30010 (CONF-700502–, pp 191-209) SNAM PROCESS FOR THE PRODUCTION OF CERAMIC NUCLEAR FUEL MICROSPHERES. Brambilla, G.; Facchini, A. G.; Gerontopulos, P.; Neri, D. (Agip Nucleare, Milan (Italy)).

From Symposium on Sol-Gel Processes and Fuel Cycles.

The SNAM Gel-Supported Precipitation Process, an original method for production of ceramic nuclear fuel, is described; and the present status of laboratory and pilot-plant work is reported. A basis is given for attempting a comparative evaluation of the process with sol-gel techniques. The process was fully demonstrated on a several hundred kilogram basis for UO_2, ThO_2, PuO_2 and mixed oxide particles. The preparation of other compounds such as carbides, nitrides, carbonitrides or compounds of nonnuclear metals is also feasible. (auth)

30011 (CONF-700502–, pp 210-26) A PILOT PLANT FOR CONTINUOUS PREPARATION OF U–Pu OXIDE SPHERES. Cogliati, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)); Facchini, A. (Agip Nucleare, Milan (Italy)).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Collaboration in the field of sol-gel processes between CNEN and SNAM (more recently between CNEN and Agip Nucleare, another Company of the ENI holding) has resulted in the design and operation of an experimental pilot plant for the continuous production of sizable amounts of U–Pu mixed oxide in the form of microspheres. The pilot plant consists of two separate lines, one for the production of the fine size fraction (≤100μ diameter) via a CNEN sol-gel process; the second, to produce the coarse fraction, (150 to 1100μ) is based on SNAM gel-supported precipitation process. Completion of the plant is expected at the end of 1970; so far only the course fraction unit is in operation. Details are given on process schemes and equipment choice and lay-out. (auth)

30012 (CONF-700502–, pp 227-38) PREPARATION OF PLUTONIA–URANIA SOL-GEL MICROSPHERES FOR EBR-II TESTING. Carlson, R. V. (Avco Corp., Wilmington, Mass. Research and Advanced Development Div.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

A particulate fuel consisting of 20% PuO_2–80% UO_2 in the form of spherical particles was prepared by a sol-gel process for comparison of the in-pile behavior of this fuel with the behavior of pellets, prepared from coprecipitated powder, irradiated under identical conditions. In the sol-gel process used for producing plutonia–urania fuels, separate sols of UO_2 and PuO_2 were prepared by precipitation-peptization techniques and blended in the appropriate ratio to obtain a mixed sol, which was co-gelled into spherical particles and then fired to the mixed oxide. Nearly 2.2 kg of mixed-oxide microspheres were prepared with laboratory-scale equipment for a series of irradiations in progress in the Babcock & Wilcox Test Reactor (BAWTR). A unit-operations-scale spheroidizing system was used to prepare about 1.5 kg of microspheres for testing in the fast flux of the EBR-II. The particles for both irradiation tests were prepared in two different diameter ranges, 420 to 590μ and <44μ. The ^{235}U content of the BAWTR test fuel was either 0.258% or 19.68%. For the EBR-II test fuel, the ^{235}U content was 92.68%. A description of the process used and the results obtained in the preparation of the EBR-II test fuel are presented. In addition a description of the unit-operation-scale spheroidizing system is presented. (auth)

30013 (CONF-700502–, pp 239-43) LABORATORY STUDIES OF SURFACE TENSION PROCESSES FOR THE PREPARATION OF UO_2 MICROSPHERES AT KFA. Foerthmann, R.; Naoumidis, A.; Nickel, H. (Kernforschungsanlage, Juelich (West Germany)).

From Symposium on Sol-Gel Processes and Fuel Cycles.

In connection with the development of low-enrichment coated-particle fuel for high-temperature gas-cooled reactors, irradiation tests on UO_2 coated particles with different kernel and coating parameters are necessary. For the preparation of UO_2 microspheres in a laboratory scale a process was required by which UO_2 kernels with different porosities and diameters in the range of 200 to 1000 μm can be prepared. Since the well known sol-gel processes were not suitable for preparing UO_2 kernels of diameters more than 500 μm, the application of the method of "internal gelation" to urania sols was studied. In addition to this sol-gel process a second surface tension process was developed, by which spherical UO_3 particles were obtained directly from a U^{6+}-solution. These particles could be converted to dense UO_2 microspheres by sintering in a reducing atmosphere. (auth)

30014 (CONF-700502–, pp 244-52) SOL-GEL PROCESS DEVELOPMENT AT THE EUROPEAN INSTITUTE FOR TRANSURANIUM ELEMENTS, KARLSRUHE, GERMANY. Louwrier, K. P.; Steemers, T. (European Atomic Energy Community).

From Symposium on Sol-Gel Processes and Fuel Cycles.

UO_2, UC, and $(PuU)O_2$ microspheres were formed using an internal gelation process. Uranium is used as a concentrated denitrated uranyl nitrate solution. The U^{6+} is first reduced during the thermal treatment of the microspheres. By adding carbon black to the initial concentrated denitrated uranyl solution, UC micro-

spheres are formed. By mixing a Pu hydroxide sol with the solution it was possible to form $(PuU)O_2$ microspheres. All microspheres are of high density. The diameters range from 100/u to 1 mm. (auth)

30015 (CONF-700502–, pp 253-63) A U(VI)-PROCESS FOR MICROSPHERE PRODUCTION. van der Brugghen, F. W.; Kanij, J. B. W.; Noothout, A. J.; Hermans, M. E. A. (Keuring van Electrotechnische Materialen, N. V., Arnhem (Netherlands)); Votocek, O. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu).

From Symposium on Sol-Gel Processes and Fuel Cycles.

A process is described for the production of UO_2 microspheres. It is based on a very fast precipitation of an ADU–like material from a uranyl nitrate solution by the technique of internal gelation. A number of technological and scientific aspects are discussed. (auth)

30016 (CONF-700502–, pp 264-80) CONCEPTUAL PLANT DESIGN AND PRELIMINARY EVALUATION OF SOL-GEL VERSUS PELLETS PRODUCTION COSTS. Colombi, G.; Podo, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Cost estimates were made for fuel preparation and fabrication of sol-gel and pelletized metal-clad (U, $Pu)O_2$ fuel elements. The conceptual plant produces 30 kg of oxide fuel per day. Two processes, low-energy packing of microspheres and pelletizing were compared. As a result of this study little economic difference in favor of sol-gel processes was observed. Since all fabrication steps from welded and tested pin preparation to the final assembled fuel element are constant and only depending on the arbitrary design, cost estimates do not cover this part. Finally, costs of fuel material, fuel inventory, and cladding material were not included since they are supposed to be the same for both processes. (auth)

30017 (CONF-700502–, pp 281-309) ECONOMICS AND TECHNOLOGY OF HIGH-TEMPERATURE GAS-COOLED REACTOR FUEL REFABRICATION. Furman, F. J. Jr.; Sease, J. D.; Lotts, A. L. (Oak Ridge National Lab., Tenn.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Refabrication techniques are being developed on an engineering scale. The scale of the demonstration, recent progress on the development of processes and equipment for refabrication, and economics of refabrication are described. Work on particle transfer, screening, shape separation, pyrolytic carbon coating, and inspection is reported. The coating of fuel particles in recent semiproduction runs with both a laboratory coater and a prototype remotely operable coater is discussed. The work done on fuel stick making and fuel element assembly is also presented. The cost of refabrication as a function of processing rate is presented, along with a discussion of the most favorable time to initiate refabrication operations in a growing HTGR industry. The economically favorable period for the start of refabrication operations was found to be five to nine yr after the completion of the first 1000 Mw(e) HTGR. (auth)

30018 (CONF-700502–, pp 310-22) PACKING OF FUELED SPHERES. Ayer, James E. (Argonne National Lab., Ill.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Model studies showing the effects of factors governing the packing of spheres and the rate at which final density is reached are discussed. The results of the background work, using an infiltration technique, are compared with findings from the fabrication of fuel rods containing (U, $Pu)O_2$ in three forms. Changes in the axial density of fuel rods are determined by gamma absorptometry. The results are used as the basis for comparison of columns containing vibrationally compacted and pelleted fuel. Selected fabrication development work showing the versatility of spherical forms for use as nuclear fuels is described. The model system shows that size ratios are the chief factors governing the packing efficiency of spheres. The rate at which final density is reached is affected by size ratio, void fraction in the matrix spheres, and vibratory mode; the greatest rate occurring at 40 to 60 Hz at accelerations less than 10 g. Fabrication of fuel rods containing (U, $Pu)O_2$ in the form of pellets, angular shards, and sol-gel spheres showed that the sol-gel spheres behave as predicted by the model. Gamma absorptometry of the three types of fuel rods revealed that the smallest changes in axial density of vibratorily compacted rods occur in those containing sol-gel spheres. Spherical particles are ideally suited to unique fabrication processes such as shell-and tube-type assembly loading and fabrication of integrated fuel rods without a barrier between fuel and blanket particles. (auth)

30019 (CONF-700502–, pp 323-41) SPHERE-PAC AND PELLETIZATION OF $(U,Pu)O_2$. Sease, J. D.; Reese, C. R.; Bradley, R. A.; Pechin, W. H.; Lotts, A. L. (Oak Ridge National Lab., Tenn.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Fast-reactor fuel fabrication development at ORNL was directed toward Sphere-Pac and pelletization of sol-gel-derived (U, $Pu)O_2$. Sphere-Pac is a technique for loading microspheres directly into fuel pins employing low-energy vibration. Typically, 400- to 600-μm microspheres are loaded into a 0.250-in-OD fuel pin and infiltrated with microspheres smaller than 44 μm in diameter. Development of Sphere-Pac for a production facility and experience in Sphere-Pac loading of irradiation capsules are discussed. U-Fine, a modification of Sphere-Pac in which all of the Pu is in the coarse microspheres, simplifies loading and minimizes contamination. Pelletization of sol-gel fuel involves mixing PuO_2 and UO_2 sols and drying to a gel. After grinding to –325 mesh the powder is calcined at 500 to 600°C in various atmospheres to give a sinterable powder for producing pellets with controlled densities 80 to 93% of theoretical. The effects of calcination treatment on the surface area, oxygen-to-metal ratio, and sinterability are reported. The effects of forming pressure, heating rate, sintering temperature, and furnace atmosphere on the sintered density are also discussed. Comparing the fabrication of (U, $Pu)O_2$ fuels by mechanical mixing, coprecipitation, and sol-gel pelletization with the U-Fine Sphere-Pac process indicates a cost saving with the U-Fine process. (auth)

30020 (CONF-700502–, pp 342-57) FABRICATION DEVELOPMENT OF SOL-GEL PARTICULATE FUELS. Kerr, J. M.; Bremser, A. H.; Ferrell, L. J.; Fowler, D. L.; Sherman, C. R.; Lynch, E. D. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

The work carried out on development of particulate fuels by sol-gel and gel-addition techniques since 1959 is reviewed. Work on the particulate fuel programs is continuing in the following areas: Feed Materials Development — Feed materials were prepared by mixed-sol, coprecipitation, and mechanical blending techniques. The advantages and disadvantages of these techniques in producing particulate material for compaction are discussed. Materials Characterization — Much work was conducted on the chemical and physical characterization of fuel powders and the finished product. The importance and the application of characterization are discussed, and techniques for characterizing particulate fuel are presented and related to the state of the art. Fabrication Process Development — The development of both angular- and spherical-particle fuels is discussed and related to our experience in fabricating pellet fuels for fast reactors. Discussions include vipac pilot runs on thermal reactor fuel pins, vipac of small-diameter pins, and sphere-pac of thermal and fast reactor fuel capsules for irradiation. Irradiation Testing — Tests were conducted in both thermal and fast flux environments. (auth)

30021 (CONF-700502–, pp 423-33) FACTORS THAT CONTROL THE CARBOTHERMIC SYNTHESIS OF ADVANCED FUELS. Lindemer, T. B. (Oak Ridge National Lab., Tenn.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Considerable effort was expended to synthesize the carbides, nitrides, and carbonitrides of uranium, plutonium, and their solid solutions by the carbothermic reduction of oxide-carbon mixtures produced by the sol-gel process. Many factors affect the time required to accomplish the synthesis. These factors are directly related to the thermodynamics of the reactions, the diffusional mechanisms in the system, and the particular processes used for the conversion. These factors are reviewed for fuel systems of current interest. (auth)

30022 (CONF-700502–, pp 434-47) CARBOTHERMIC CONVERSION OF SOL-GEL U AND Pu OXIDES TO CARBONITRIDES. Notz, K. J.; Haire, R. G.; Bond, W. D.; Farrar, L. G. (Oak Ridge National Lab., Tenn.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Shards and microspheres of UO_2-C and UO_2-PuO_2-C that were prepared by sol-gel processes were converted to U(C,N) and $U_{0.8}$, $Pu_{0.2}$) (C,N) at 1500 to 1900°C by a reaction-sintering process. Carbonitrides were prepared over the composition range $M(C_{0.8}$, $N_{0.2})$ to $M(C_{0.2},N_{0.8})$. The products were low in oxygen content, containing 100 to 1000 ppM. Shards generally contained 500 to 1000 ppM oxygen; microspheres contained 100 to 800 ppM oxygen. Carbonitride microspheres were about 90% of the theoretical crystal density value and shards were only about 50 to 75% of the theoretical value. The carbonitride products produced were characterized by chemical analysis, mercury porosimetry, x-ray diffractometry, and metallography. (auth)

30023 (CONF-700502–, pp 510-20) INVESTIGATIONS ON POROUS UO_2 SPHERES MADE BY A SOL-GEL PROCESS. Hardy, C. J.; Hyde, K. R.; Lyon, C. E. (Atomic Energy Research Establishment, Harwell (England)).

From Symposium on Sol-Gel Processes and Fuel Cycles.

A two-stage calcination procedure was used to introduce controlled amounts of porosity into UO_2 spheres made by a sol-gel process. The gel spheres were calcined initially in CO_2 or air, followed by sintering in hydrogen at 1450°C. Open porosities of 10 to 35% were obtained by calcining initially in air and closed porosities of up to 20% by calcining initially in CO_2. The structure of the external and internal surfaces of the spheres was examined by optical and scanning-electron microscopy. (auth)

30024 (CONF-700502–, pp 551-66) INVESTIGATIONS ON THE PREPARATION OF UO_2 MICROSPHERES BY INTERNAL GELATION OF A UO_2 SOL AND FROM A URANIUM(VI) SOLUTION. Foerthmann, R.; Naoumidis, A.; Nickel, H.; Burck, W. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe).

From Symposium on Sol-Gel Processes and Fuel Cycles.

A sol-gel process based on the application of the internal gelation technique to concentrated low-pH urania sols is described. The results of laboratory investigations on the preparation of UO_2 microspheres with diameters of 500 to 1000 μm and more by this sol-gel process are given. A second process for preparing UO_2 microspheres is described starting from a uranium (VI) solution, which is directly processed to spherical UO_3 particles. The conditions for the heat treatment of these particles yielding UO_2 microspheres in the diameter range of 100 to 900 μm are given. (auth)

30025 (Y–1719) DISCONTINUOUS CARBON–CARBON COMPOSITE FABRICATION. Cook, J. L.; Lambdin, F.; Trent, P. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 20 May 1970. Contract W-7405-eng-26. 40p. Dep. CFSTI.

Composites consisting of short fibers in a carbon or graphite matrix were fabricated by isotropic casting, flock lay up, spray lay up, and pulp molding. Models of the fiber structures generated by each technique were considered and related to the physical and mechanical properties and processing characteristics. For hollow cylinders, the structural integrity and the rate of densification by repeated liquid resin impregnation, carbonization, and graphitization were influenced by the anisotropic behavior of the fiber structures. Selected properties of the materials resulting from these fabrication techniques were determined. (auth)

30026 (ZJE–71) WELDING PROBLEMS OF THICK-WALLED STRUCTURES OF Al–Si 1–Mg 0.5 ALLOY OPERATING AT INCREASED TEMPERATURES. Jicinsky, P. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 12p. Dep. CFSTI (U. S. Sales Only).

The example of the heavy water vessel for the first Czechoslovak reactor manufactured of Al–1.0% Si–0.5% Mg alloy demonstrated the problems which were met in welds of heavy thickness semi-products of this alloy group hardenable by heat treatment. Some results of short as well as long term tests are shown, the mechanical properties stability at various states of heat treatment is briefly dealt with and the effect of test specimen size on the measured mechanical properties of the structural material under investigation is mentioned. (auth)

30027 ELECTROCHEMICAL GROWTH OF NpO_2 SINGLE CRYSTALS. Martinot, L.; Machiels, A.; Fuger, J.; Duyckaerts, G. (Lab. of Nuclear Chemistry, Liege). Bull. Soc. Chim. Belg.; 79: 125-31(Jan-Feb 1970).

NpO_2 single crystals were prepared by electrochemical reduction of neptunyl chloride in LiCl–KCl between 700 and 870°C, both on pyrolytic graphite and platinum cathodes. The lattice parameter is $a = (5.433 \pm 0.001)$ Å. (auth)

30028 PREPARATION OF β-MOLYBDENUM NITRIDE. Karam, Ronald; Ward, Roland (Univ. of Connecticut, Storrs). Inorg. Chem.; 9: 1385-7(Jun 1970).

The preparation of pure β-molybdenum nitride, stable at room temperature, is achieved by reaction of the elements catalyzed by calcium nitride. The x-ray powder diffraction pattern is indexed using a tetragonal unit cell, $a = 8.41$ Å and $c = 8.05$ Å. The suggested formula is $Mo_{16}N_7$. The compound has a temperature-independent paramagnetism above 175°K. Below this temperature, Curie–Weiss behavior is observed. (auth)

30029 REACTION KINETICS OF THE SULFURIZATION OF THE PULVERULENT TUNGSTEN BY SULFUR VAPOR AT VERY LOW PRESSURE. Lambertin, Michel; Colson, Jean-Claude; Delafosse, Denise (Dijon Univ., France). Compt. Rend., Ser. C; 270: 974-7(16 Mar 1970). (In French).

The sulfurization of pulverulent tungsten at a very low vapor pressure of sulfur (3.10^{-2} torr) produces WS_2. The reaction rate is fixed by the external interfacial process modulated by the morphological factors. The results obtained can be compared with those found when the sulfurization agent used was hydrogen disulfide. (auth) (France)

30030 PREPARATION OF THORIA DISPERSION HARDENED IRON. Place, T. Alan; Lund, John A. (Univ. of British Columbia, Vancouver). Int. J. Powder Met.; 6: 59-66(Apr 1970).

Co-precipitation leading to finely dispersed thoria and an iron matrix and hot rolling the compact resulted in a useful material. (auth)

30031 THE PREPARATION AND EVALUATION OF CEMENTED TITANIUM–VANADIUM CARBIDE CUTTING TOOLS. Precht, Walter (Research Inst. for Advanced Studies, Baltimore). Int. J. Powder Met.; 6: 69-74(Apr 1970).

Cobalt bonded titanium–vanadium carbide cermets were prepared and compared with commercial carbide cutting tool materials and have some distinct advantages. (auth)

30032 PROGRESS IN THE DEVELOPMENT OF FUEL AND FUEL ELEMENTS FOR HIGH TEMPERATURE REACTORS OF THE PEBBLE BED TYPE. Herrmann, F. J.; Vygen, P. (Nuklear-Chemie und -Metallurgie GmbH, Wolfgang, Ger.). Kerntechnik; 12: 159-64(Apr 1970). (In German and English).

The emulsion process used for the manufacture of spherical fuel kernels makes it possible to vary the porosity and the diameter of the kernels within a wide range. The technique developed for coating these kernels with pyrolytic carbon makes it possible to achieve layer combinations and layer properties satisfying the requirements of high temperature reactors. Both the manufacture and the coating of the fuel particles have been scaled up to approach industrial production units. A molded variant of a spherical fuel element has been developed with chemical and physical properties satisfying the requirements of high temperature power reactors. (auth)

30033 MONALITE SHIELDING MATERIALS ON A CERAMIC BASIS. Schumann, H. (Univ., Wuerzburg, Ger.). Kerntechnik; 12: 165-70(Apr 1970). (In German and English).

Oxidic barium minerals, zirconium oxide, lead minerals, bismuth oxide, boron oxide, and oxides of rare earth metals, sintered at temperatures between 800 and 1400°C, form ceramic materials with densities ranging up to 6.1 g/cm³. The attenuation coefficients for gamma radiation are better than those of any commonly used materials except lead. The capture cross-sections for thermal neutrons range up to 2200 barn. These materials are suitable for uses involving high radiation intensities simultaneously with high temperatures. Owing to their very low thermal conductivity, some of these materials can be used for the combined shielding of ionizing radiation and heat. (auth)

30034 FABRICATION AND IRRADIATION OF THULIUM SESQUIOXIDE. Keski, J. R.; Smith, P. K. (E. I. du Pont de Nemours and Co., Inc., Aiken, S. C.). Contract AT(07-2)-1. Amer. Ceram. Soc. Bull.; 49: 539-42(May 1970).

Chemical and physical properties, fabrication, and reactor irradiation of thulium sesquioxide are discussed. Sintered wafers up to 97% of theoretical density were fabricated from reprocessed oxide powder. Wafers were irradiated to about 1.8 W/g with no change in microstructure or dimensions. (auth)

30035 PLASMA-SPRAYED URANIUM CARBIDE COATING OF GRAPHITE CRUCIBLES. Koch, J. C. (National Lead Co. of Ohio, Cincinnati). Contract AT(30-1)-1156. Amer. Ceram. Soc. Bull.; 49: 549-50(May 1970).

Graphite crucibles were protected from chemical attack at elevated temperatures with a plasma-sprayed coating of UC. Bulk UC was finely ground and sprayed in an environmental chamber using a nitrogen atmosphere and a plasma gun. (G.M.C.)

Properties Evaluations

Refer also to abstracts 29260, 29434, 29938, 29944, 29964, 30052, and 31094.

30036 (AERE-R-6301) A GALVANIC CELL TECHNIQUE FOR THE RAPID MEASUREMENT OF VARIATIONS OF O/U RATIOS IN OXIDE FUEL PELLETS. Bones, R. J.; Carney, R. F. A. (Atomic Energy Research Establishment, Harwell (England)). Dec 1969. 13p. Dep. CFSTI (U. S. Sales Only). UK 3s. 0d.

A miniaturized high temperature galvanic cell in the form of a fine probe has been developed. This allows the determination of

O/U ratios at localized points in a uranium oxide pellet. The technique has been employed, using multiple probes, to determine the radial distribution of oxygen across a reactor fuel pellet. Measurements are made at 700 to 750°C where equilibrium is attained within minutes. The apparatus permits a rapid, non-destructive determination of oxygen redistribution in a temperature gradient. With development it should be applicable to uranium/plutonium oxides and, used remotely, for irradiated fuels. (auth) (UK)

30037 (NP-tr-1891) PROPERTIES AND ELECTRICAL CONDUCTIVITY OF Zr CERAMICS STABILISED WITH Y_2O_3. Ezerskii, M. L.; Kozlova, N. I.; Popil'skii, R. Ya.; Demonis, I. M. Translated by S. Dobrianskyj for Australian Atomic Energy Commission, from Izv. Akad. Nauk SSSR, Neorg. Mater.; 4: 1599-1600(Sep 1968). 7p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article prepared from the original, appeared as NSA 23: 14403 (1969).

30038 PROPERTY CHANGES OF VANADIUM DUE TO NITROGEN AND OXYGEN IN SOLID SOLUTIONS. Hoerz, Gerhard (Max-Planck Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 61: 371-8(May 1970). (In German).

The electrical resistivity, thermoelectric power, magnetic susceptibility, lattice parameter, internal friction, and Vickers hardness of V-N and V-O solid solutions were determined as a function of concentration. The property changes were compared with corresponding data of the Nb-N, Nb-O, Ta-N and Ta-O solid solutions. (auth)

Structure and Phase Studies

Refer also to abstracts 29396 and 30152.

30039 (AECL-3517) PHASE IDENTIFICATION IN THE U-Si SYSTEM. Berthiaume, L. C. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Dec 1969. 13p. Dep. CFSTI (U. S. Sales Only). AECL $0.50.

Eight phases (U, U_3Si, U_3Si_2, USi, U_2Si_3, USi_2, USi_3 and Si) are reported to occur in the uranium-silicon system. The preparation of samples corresponding in composition to these phases, and the identification of each phase using the electron microprobe are described. The phases were characterized with respect to distribution, etching behavior, and microhardness. The results permit identification of the phases without using the electron microprobe. (auth)

30040 (ORNL-tr-2313) PHASE EQUILIBRIA IN THE SYSTEMS NEPTUNIUM OXIDE/RARE EARTH OXIDES (Ho, Er, Tm, Yb, Lu). Keller, C.; Engerer, H.; Leitner, L.; Sriyotha, U.; Berndt, U. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from J. Inorg. Nucl. Chem.; 31: 3421-6(1969). 5p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 3037.

30041 SITE SYMMETRY OF Eu^{3+} IN FLUX-GROWN ZIRCON. Fielding, P. E. (New England Univ., Armidale, Australia). Aust. J. Chem.; 22: 2463-5(Nov 1969).

Emission spectra from zircons grown in flux melts cooled at varying rates are reported, and it is shown that Eu^{3+} ions occupy three sites of different symmetries. (Australia)

30042 VALIDITY OF VEGARD'S LAW FOR UC-UN SOLID SOLUTION. Kai, Hiroshi; Katsura, Masahiro; Sano, Tadao (Osaka Univ.). Nippon Genshiryoku Gakkaishi; 12: 116-23(Mar 1970). (In Japanese).

The validity of Vegard's law for UC-UN solid solutions is still in dispute. A discussion is given on the possible causes of this disagreement among published papers on this subject. The factors taken up include oxygen contamination, errors of chemical analysis in determining the composition of solid solution, slower than expected reaction rate, nonstoichiometry of solid solution, coexisting second phase, and the state of distribution of carbon and nitrogen atoms in the UC-UN lattice. Experiments were performed in vacuo and in nitrogen gas in order to obtain the relation betwen the lattice parameter and the composition of solid solution, and to determine the effects brought upon this relation by the factors cited above. The lattice parameters of UC-UN solid solution obtained by vacuum sintering at 1,700 and 1,800°C showed a positive deviation from Vegard's law. The same parameters when the solid solution coexisted with UC_2 deviated similarly from Vegard's law. The presence of oxygen in the UC-UN solid solution caused little change of lattice parameters in the vicinity of $UC_{0.5}N_{0.5}$. (auth) (NSA of Japan)

30043 NEW INTERMEDIATE PHASES REVEALED BY THE IN SITU FLUORINATION OF URANIUM OXIDE UO_2 IN A FAST ELECTRON DIFFRACTOMETER. Idrissi, Rachid; Kikindai, Tivadar; Auguin, Bernard; Vigner, Daniel (Ecole Centrale des Arts et Manufactures, Chatenay-Malabry, France. CEA, Fontenay-aux-Roses, France. CEA, Saclay, France). Compt. Rend., Ser. C; 270: 765-8(2 Mar 1970). (In French).

The compounds $La_2Ti_2O_7$ and $Nd_2Ti_2O_7$ were prepared as single crystals by the flux method. These crystals are twinned and found to be monoclinic ($P2_1/m$). The lattice parameters were determined. Several anomalies presented by the Weissenberg and by the rotating-crystal diagrams originated from twinning. (auth) (France)

30044 STUDY OF THE STRUCTURE OF THE COMPOUNDS $La_2Ti_2O_7$ AND $Nd_2Ti_2O_7$. Queyroux, Francine (CNRS, Vitry, France); Huber, Michel; Collongues, Robert. Compt. Rend., Ser. C; 270: 806-8(2 Mar 1970). (In French).

The in situ fluorination of the monocrystals of UO_2 in a fast electron diffractometer revealed various intermediate phases $(UO_2) \times F_y$ indicating the various steps of transformation from UO_2 to UO_2F_2. (auth) (France)

30045 URANIUM AND ALKALINE EARTH ELEMENTS SULFIDES. Brochu, Robert; Padiou, Jean; Prigent, Jacques (Rennes Univ., France). Compt. Rend., Ser. C; 270: 809-10 (2 Mar 1970). (In French).

The compounds MU_2S_5 (M = Ca, Sr, Ba) were prepared, either by the reaction of the carbon sulfide on the diuranates MU_2O_7, or by the reaction of monosulfides with β US_2 or with uranium and sulfur. Their structure is identical to that of U_3S_5 and they crystallize in the orthorhombic system with four bases in each crystal lattice. Magnetic measurements confirm an oxidation degree of IV for uranium. (auth) (France)

30046 STUDY OF THE ZIRCONIA-NEODYMIUM SESQUIOXIDE SYSTEM AT HIGH TEMPERATURE. Rouanet, Alain (CNRS, Odeillo, France). Compt. Rend., Ser. C; 270: 802-5 (2 Mar 1970). (In French).

The phase diagram of the system $ZrO_2-Nd_2O_3$ presents an eutectic at 2115°C (30 mol % ZrO_2-70 mol % Nd_2O_3) and an inflection of the liquidus for the neodymium zirconate composition. The eutectic comprises a body-centered cubic phase C_2 (Tl_2O_3 type) with the limiting composition 40 mol % ZrO_2-60 mol % Nd_2O_3 and another cubic phase X (20 mol % ZrO_2). No domain of homogeneity could be observed for their last phase. All the compounds studied were quenched at the fusion point and analyzed by x-ray diffraction. The nature and the extent of the quenched phases are compared with those of the phases in equilibrium near the solidus. The phase X cannot be quenched and appears to give rise to a hexagonal phase A (through fast quenching) whose parametric variations are studied. (France)

30047 ELECTRON MICROSCOPIC STUDY OF PLANAR INTERFACES RESULTING FROM THE MONOCLINIC TO TETRAGONAL PHASE TRANSITION IN VO_2. Hayashi, Y. (SCK-CEN, Mol, Belg.); Van Landuyt, J.; Amelinckx, S. Cryst. Lattice Defects; 1: 185-8(Mar 1970).

Vanadium dioxide has a monoclinic-to-tetragonal phase transformation at about 70°C. This transformation can be directly observed in the electron microscope. Partial transformation allows the boundaries between the two phases to be studied. If the tetragonal phase is transformed into monoclinic, the crystal is broken up into domains according to different modes of transformation. The resulting different types of interfaces between domains are predicted and compared with observations. (auth)

Radiation Effects

Refer also to abstracts 29983, 31076, and 31081.

30048 (BNWL-1323) INTERIM BURST TEST RESULTS ON EBR-II IRRADIATED FUEL PIN SECTIONS. Fish, R. L.; Holmes, J. J.; Leggett, R. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr 1970. Contract AT(45-1)-1830. 23p. Dep. CFSTI.

Burst tests were conducted at 900°F on specimens prepared from 75% UO_2-25% PuO_2 fuel pins clad with 0.250 in. OD × 0.016 in. wall Type 304 stainless steel (PNL-1-3 and 1-6) that were irradiated in EBR-II to ~8000 MWd/Mtm at 8 to 9 kW ft. Argon gas was used to internally pressurize the fuel pin sections and the fuel was left intact. Specimens taken from above the midplane but within the fuel column exhibited brittle, intergranular fracture at drastically lower stresses (~30,000 psi) than would be expected from

Type 304 stainless steel irradiated under similar conditions. The measurable strain in these specimens was less than 1%. Fueled specimens from below the midplane and specimens from the fission gas plenum exhibited a ductile, transgranular fracture at stresses and strains normally expected. Post-test examination of the burst test specimens included diameter measurements, optical metallography, electron microscopy, and shielded electron microprobe analysis. Fueled specimens from above the midplane contained $M_{23}C_6$ and sigma phase at the grain boundaries of the cladding whereas the cladding of specimens from below the fuel midplane was free of grain boundary precipitates. Fuel particles containing cesium and other fission products were observed on the inner surface of the cladding and one area, containing cesium but no fuel, was observed at a location ~8 microns inside the cladding. (auth)

30049 (CONF-700502–, pp 359-73) IRRADIATION PERFORMANCE OF SOL-GEL $(U,Pu)O_2$ FUELS FOR BREEDER REACTORS. Cox, C. M.; Fitts, R. B.; Olsen, A. R.; Lotts, A. L. (Oak Ridge National Lab., Tenn.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Eleven $(U, Pu)O_2$ fuel pins and five UO_2 pins were irradiated in uninstrumented capsules to burnups up to 6% FIMA in the Engineering Test Reactor. All but one of these fuel pins contained sol-gel Sphere-Pac fuel. The tests showed that Sphere-Pac fuel pins perform well to such burnup levels. Both Sphere-Pac and pelletized sol-gel (0.8 U to 0.2 Pu)O_2 fuel pins were tested in highly instrumented irradiation capsules. These tests showed that the in-reactor thermal conductance of the two agree within 10% for fuel center temperatures over at least the range 500 to 1600°C. The fuel temperatures for both can be calculated quite accurately over this range using out-of-reactor pellet thermal conductivity data. Three Sphere-Pac and three pelletized sol-gel (0.8 U to 0.2 Pu)O_2 fuel pins were subjected to severe power transients at the Transient Reactor Test Facility. No fuel pins failed even though two Sphere-Pac pins were subjected to a transient which probably melted 50 to 60% of the fuel in the peak power region. Tests in progress include thermal flux tests with burnups at 9% FIMA and the first fast flux tests of sol-gel fuel, in which five Sphere-Pac fuel pins have reached a burnup of 5% FIMA in the EBR-II reactor. (auth)

30050 (CONF-700502–, pp 374-413) IRRADIATION TESTS OF SOL-GEL PRODUCTS. Cervellati, A.; Falcinelli, G.; Lepscky, C.; Cogliati, G.; Guermani, P.; Testa, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Some irradiation experiments carried out in the RS-1 swimming pool reactor in Italy and in the Halden BHWR in Norway under the Plutonium Program and the Italian Fast Reactor Program are described. Their fundamental purpose is the acquisition of the necessary know-how for designing and manufacturing fuel elements to be used in a commercial fast power station. (auth)

30051 (CONF-700502–, pp 414-21) IRRADIATION PERFORMANCE OF SOL-GEL UO_2–20 PERCENT PuO_2 SPHERICAL PARTICLES. Baroch, C. J.; Harbinson, E. N. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Mixed oxide fuels (UO_2–PuO_2) were selected for use in the FFTF and in early LMFBRs. An irradiation program is being carried out to evaluate the performance of angular particles, spherical particles, and pellets irradiated under identical conditions. These irradiations in the Babcock & Wilcox Test Reactor and the EBR-II will determine the effect of heat rate and burnup on the restructuring characteristics, swelling behavior, and gas release characteristics of these fuels. (auth)

30052 (CONF-700502–, pp 567-84) IRRADIATION PERFORMANCE OF $(U,Th)O_2$ COATED FUELS FOR HTGR's. Coobs, J. H.; Olsen, A. R.; Scott, J. L.; Hewette II, D. M.; Long, E. L. Jr. (Oak Ridge National Lab., Tenn.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

A test program consisting of a series of thermal stability and irradiation tests is being conducted on $(U, Th)O_2$ coated-particle fuels. The coated particles used were designed by a mathematical model and fabricated according to technology previously developed at ORNL. In isothermal annealing studies the coated mixed oxides proved to be stable for long periods at 2200°C and even for a few minutes at 2600°C. Coated mixed-oxide fuels demonstrated good performance in irradiation experiments in the Dragon Reactor, ETR, and HFIR to burnups of approximately 20% FIMA and fast neutron fluences as high as 8×10^{21} neutrons/cm^2 (>0.18 MeV) at temperatures of 1000 to 1250°C. In the Dragon and HFIR experiments the coated mixed oxides were compacted or bonded in a graphite or carbonaceous matrix as currently specified for all HTGR fuels. (auth)

30053 (GEAP-13549) PERFORMANCE OF PLUTONIUM–URANIUM MIXED-OXIDE FUEL PINS IRRADIATED IN A FAST REACTOR (EBR-II) TO 50,000 MWd/Te. Nelson, R. C.; Baily, W. E.; Duncan, R. N.; Spalaris, C. N.; Zebroski, E. L. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Aug 1969. Contract AT(04-3)-189. 114p. Dep. CFSTI.

Twelve encapsulated mixed-oxide fuel pins were irradiated in the EBR-II fast reactor core to about 50,000 MWd/t burnup. These fuel pins were part of a study to investigate various fuel pin design parameters. Fuel pin performance was evaluated by extensive post-irradiation examinations. Eleven of the fuel pins, clad with Type 316 or 347 stainless steel, remained intact. One fuel pin, F2F, clad with Incoloy-800, failed, probably as a result of a defective weld. The eleven intact pins were found to be in excellent condition with a maximum of about 0.001 inch cladding distortion. Details of the examination and additional results are reported. (auth)

30054 (ORNL-TM-2994) THE DISTRIBUTION OF FISSION PRODUCT TRITIUM IN A ZIRCALOY-CLAD UO_2 BLANKET ROD FROM PWR-1. Goode, J. H.; Cox, C. M. (Oak Ridge National Lab., Ten.). Jun 1970. Contract W-7405-eng-26. 30p. Dep. CFSTI.

The given Zircaloy-2-clad UO_2 blanket rod had been irradiated to 3.41% FIMA at a time-averaged linear heat rate of 4.84 kW/ft, with a clad temperature of 259°C, for the full life of the first core of the Shippingport Pressurized Water Reactor. It was destructively examined to determine the distribution of fission product tritium. There was apparently no loss of tritium from the rod; 7% of the yield of tritium was found in the Zircaloy metal cladding (apparently as the tritide) and 93% in the UO_2 fuel. (auth)

30055 CHANGES OF X-RAY DIFFRACTION PROFILES OF NEUTRON-IRRADIATED GRAPHITE WITH ANNEALING. Inagaki, Michio (Nagoya Univ., Japan); Tsuzuku, Takuro. Tanso; No. 60, 2-7(Mar 1970). (In Japanese).

Annealing effects on the x-ray diffraction profiles of a neutron-irradiated graphite dosed to 7.2×10^{20} nvt (Ni) were studied. The stepwise annealing was performed at various temperatures between 800 and 2300°C for 60 min under the reduced pressure of about 10^{-2} torr. The (001) diffraction lines were observed to shift gradually to higher angle side with the increase in annealing temperature, accompanied by sharpening of the profiles themselves. The dependence of apparent c_0-spacing measured from (002) line on the annealing time was very similar to those found for soft carbons on their graphitization process. Three-dimensional diffraction line (112) was observed after the annealing above 1200°C. These results are consistent with the behavior of electronic and mechanical properties obtained for the same kind of specimen of neutron-irradiated graphite. Both (002) and (004) diffraction profiles were unsymmetrical up to the annealing temperature of 1400°C. However, (004) profile was apparently less unsymmetrical than (002), and c_0-spacing obtained from (004) profile was always less than that from peak position of (002). This fact seems to suggest that the irradiated graphite on annealing consists of multiple structural components, which have different concentrations of some imperfections (for example, displacement of carbon atoms from graphite-like layer plane), and produce different contributions to (002) and (004) reflections. Based upon this assumption, a graphical separation of the observed (002) profile into two structural components was examined. (auth) (NSA of Japan)

30056 RADIATION INDUCED PHASE TRANSFORMATIONS IN $BaTiO_3$ AND $PbTiO_3$. Solov'ev, S. P.; Kuzmin, I. I.; Zakurkin, V. V. (Inst. of Physical Chemistry, Moscow). Ferroelectrics; 1: No. 1, 19-22(Mar 1970).

Radiation damage measurements using a nuclear reactor (E > 1 MeV) were made on $PbTiO_3$ ceramic as well as single crystal and ceramic $BaTiO_3$. Changes in the dielectric properties and structural modifications were identified. In the case of $BaTiO_3$, a decrease in the c/a ratio was found as a function of damage. Also, a shift of the T_c occurred: $\Delta T_c = -23$°C at nvt $\simeq 3 \times 10^{18}$ n/cm^2. A cubic modification of $BaTiO_3$ occurred at an integrated dosage of nvt = 7×10^{18} n/cm^2. In contrast for the $PbTiO_3$, the c/a ratio was found to increase and at fluxes higher than nvt = 8×10^{19} n/cm^2 evidence of metallic lead was found. A geometrical model is presented as well as a thermodynamic treatment of the data which is in qualitative agreement with the experimental results. (auth)

30057 EXPLANATION OF SUPRALINEARITY IN THERMOLUMINESCENCE OF LiF IN TERMS OF THE INTERACTING TRACK MODEL. Dobson, Peter N. (Univ. of Hawaii, Honolulu); Midkiff, Ann A. Health Phys.; 18: 571-3(May 1970).

A model proposed by Claffy et al., (Proc. Gatlinburg Conf. p302. USAEC Conf-680920 (1968)), in which luminescence centers are created along the tracks of incoming particles and supra-linearity is qualitatively explained by the interaction between tracks, is discussed. A simple formula based on this model is derived to explain quantitatively the dose–thermoluminescence relationship and it is shown to give an excellent fit to some simple data. (UK)

Plastics and Other Materials

Refer also to abstracts 29379, 31056, and 31134.

30058 (BDX–613–135) BONDING STRENGTH OF ENCAPSULATING MATERIALS TO HOOKUP WIRE. Crockett, Rolf R. (Bendix Corp., Kansas City, Mo.). Jun 1969. Contract AT(29-1)-613. 45p. Dep. CFSTI.

Knowledge of the effect of rigorous conditioning on the bond strengths between encapsulating materials and insulated wire is necessary for the fabrication of encapsulated, insulated hookup wire for cable assemblies in weapon applications. Data of the effectiveness of bonds between two encapsulating systems and six types of insulated wire following temperature, thermal and mechanical shock, neat aging, ozone, humidity, and composite environment conditionings are presented. Information on best bonds obtained is included in the conclusions. Data, presented both in tabular and graphic form, and illustrations are included. (auth)

30059 (ORNL-tr-2309) BEHAVIOR OF CONCRETE IN THE PRESENCE OF THERMAL STRESSES AND RADIATION. Report No. 7. Crispino, E.; Granata, S.; Risoluti, P. (AGIP Nucleare, Milan (Italy)). Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from the 2nd Conference on Prestressed Concrete Reactor Vessels and their Thermal Insulation, Brussels, Belgium, November 18–20, 1969. 38p. (CONF-691112–5). Dep CFSTI.

Investigations directed toward characterization of concrete materials by measurement of creep, thermal conductivity, and thermal expansion are described. A standard concrete was developed for structural uses in temperatures up to 300°C. Another concrete, named B.H.T., was developed which is suitable for use as structural material up to 500°C. (J.R.D.)

30060 IMPROVED COTTON FIBRE. Dasgupta, Sharda (to Atomic Energy of Canada Ltd.). British Patent 1,188,689. 22 Apr 1970. Filed 25 Feb 1966.

Reference is made to a new cotton fibre produced by irradiation graft copolymerization with mixtures of ethylenically unsaturated monomers. The fibre has high tensile strength, increased crease recovery, good dimensional stability, higher dye-acceptability, resistance to fungus and to water, and good handling properties. The monomer mixture may comprise any two of the following: styrene, methyl methacrylate, acrylonitrile, and acrylic acid: The production process is described and comprises the following steps: (i) forming a grafting solution comprising a mixture of the two monomers, such that when the monomer mixture includes styrene but not acrylic acid the solvent is methanol, ethanol or a mixture of these alcohols and optimally up to 10% by volume of water; or when the monomer mixture includes methyl methacrylate but not acrylic acid the same solvent and up to 35% of water; or when the monomer mixture includes acrylic acid the same solvent and up to 5% of water; and when the other monomer is acrylonitrile some dimethyl formamide is added: (ii) immersing the cotton to be grafted in the grafting solution and subjecting it to 3×10^5 to 5×10^5 R of γ-radiation at a dose rate of 1×10^5 to 7×10^5 R/hr. Examples are given of applications of the process. (UK)

30061 PREDICTION OF LIFE EXPECTANCY OF INSULATING MATERIALS USED IN NUCLEAR TECHNOLOGY. Lebok, Franz. Elektrotech. Z., B; 22: No. 4, 63-8(Feb 1970). (In German).

Present capabilities to predict the life expectancy of technical insulation material are reviewed. Deterioration of insulation material is theoretically as well as experimentally analyzed for thermal and voltage effects. However, aging under the influence of dynamic factors as well as ionizing radiation is still under investigation. For various insulation materials, deterioration effects caused by temperature, voltage, mechanical stresses, and nuclear radiation are presented in tables and graphs. Twenty references are given. (H.B.G.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Cosmic Ray Exposure Ages

30062 URANIUM MEASUREMENTS IN HYPERSTHENE CHONDRITES AND THEIR RELATION TO THE 600 TO 700 MILLION YEAR EVENT. Fisher, David E. (Inst. of Marine Sciences, Miami, Fla.). Earth Planet. Sci. Lett.; 7: 278-80 (Dec 1969).

The results of an investigation by homogenized fission-track analysis of the uranium abundance in 19 hypersthene chondrite falls are reported. (W.D.M.)

30063 ISOTOPIC COMPOSITION OF GADOLINIUM AND NEUTRON-CAPTURE EFFECTS IN SOME METEORITES. Eugster, O.; Tera, F.; Burnett, D. S.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). J. Geophys. Res.; 75: 2753-68(10 May 1970).

The isotopic composition of Gd in one chondrite, two achondrites, and the silicate inclusions of two iron meteorites was determined. When corrected for mass discrimination, Gd in all samples except the Norton County achondrite shows the same relative isotopic abundances as terrestrial Gd. These results set an upper limit of 3×10^{15} neutrons per cm^2 on a differential integrated thermal neutron irradiation of the Earth and these meteorites. Neutron-capture effects are present in Gd extracted from the Norton County achondrite. These most probably have been produced by secondary neutrons during the exceptionally long cosmic-ray exposure of this large stone meteorite. The isotopic anomalies correspond to an integrated thermal neutron flux of $(6.3 \pm 0.9) \times 10^{15}$ neutrons per cm^2. The present abundances of terrestrial Gd found for ^{160}Gd, ^{158}Gd, ^{157}Gd, ^{156}Gd, ^{155}Gd, ^{154}Gd, and ^{152}Gd are 21.863, 24.835, 15.652, 20.466, 14.800, 2.1809, and 0.2029, respectively. Because of the higher precision, these abundances should replace the currently accepted values. (auth)

30064 NEUTRON CAPTURE EFFECTS IN Gd FROM THE NORTON COUNTY METEORITE. Eugster, O.; Tera, F.; Burnett, D. S.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Earth Planet Sci. Lett.; 7: 436-40(Feb 1970).

The isotopic composition of Gd in one chondrite, two achondrites, and the silicate inclusions of two meteorites was determined. When corrected for mass discrimination, Gd in all samples except the Norton County achondrite shows the same relative isotopic abundances as terrestrial Gd. These results set an upper limit of 3×10^{15} neutrons per cm^2 on a differential integrated thermal neutron irradiation of the Earth and these meteorites. Neutron capture effects are present in Gd extracted from the Norton County achondrite. These most probably have been produced by secondary neutrons during the exceptionally long cosmic-ray exposure of this large stone meteorite. The isotopic anomalies correspond to an integrated thermal neutron flux of $(6.3 \pm 0.9) \times 10^{15}$ neutrons per cm^2. (auth)

Stars

30065 (LA-4406-TR) DYNAMIC EVOLUTION OF GLOBULAR CLUSTERS. Henon, M. Translated for Los Alamos Scientific Lab., N. Mex., from Ann. Astrophys.; 24: 369-419(1961). 84p. Dep. CFSTI.

The structure and evolution of globular clusters are closely linked, and they were studied simultaneously using a theoretical approach. The fundamental equations are established, and it is found that the cluster's radius is proportional to the cube of its mass and that the density is infinite at its center. These equations yield a unique solution, the "homology model," in which the outer radius is about ten times the mean radius, the mass decreases linearly as a function of time, and about one-third of the negative energy is carried off by the stars that escape, while the rest accumulates in the center. This model is the final state to which all clusters tend. The results agree well with observational data. ω Centauri is the only cluster whose central density is not yet infinite, indicating that the age of the globular clusters lies between 24×10^9 and 44×10^9 years. (auth)

30066 STARK BROADENING IN THE TWO-LEVEL APPROXIMATION. Dyne, R. J. (Univ. of Queensland, Brisbane). Proc. Astron. Soc. Aust.; 1: 242-3(Mar 1969).

In studies of physical conditions in plasmas, assuming that the perturbing particles are electrons, an impact theory which takes into account nonadiabatic collisions must be used to determine the electronic contribution to the width and shift of a spectral line. An exact formulation is compared with that of Griem (Phys. Rev., 125: 177(1962)) and of Vainshtein and Sobel'man (Optika I Spectroskopia, 6: 440(1959)). The main deviation is at plasma temperatures of the order of 5000°K, which are of astrophysical interest. (Australia)

30067 PURELY DISCONTINUOUS RANDOM PROCESSES IN AN IRREGULAR FORCE FIELD. II. VELOCITY VARIATION OF A STAR. Petrovskaya, I. V. (Leningrad Univ.). Sov. Astron. AJ (Engl. Transl.); 13: 957-61(May-Jun 1970).
Translated from Astron. Zh.; 46: 1220-7(Nov-Dec 1969).

The method proposed previously for solving the second Kolmogorov–Feller equation is used to investigate the evolution of the velocity distribution function for a group of stars having a prescribed initial velocity distribution and masses equal to the average mass of the stars in the cluster. The regular potential of the cluster is neglected. Determinations are made of the velocity distribution function for the stars in the group, the proportion of escaping stars and the proportion of energy removed by them at various epochs t, and the function that the velocity distribution in the cluster approaches as $t \to \infty$. (auth)

30068 VLASOV EQUATION AND IRREVERSIBILITY IN PLASMA PHYSICS AND STELLAR DYNAMICS. Genkin, I. L. (Astrophysical Inst., Alma-Ata, USSR). Sov. Astron. AJ (Engl. Transl.); 13: 862-3(May-Jun 1970).
Translated from Astron. Zh.; 46: 1228-30(Nov-Dec 1969).

A new statistical definition of entropy is proposed that corresponds most closely to the fundamental (thermodynamic) definition. The concept of an effective relaxation time is introduced. (auth)

30069 MODEL FOR GLOBULAR CLUSTERS WITH A NON-UNIFORM STAR POPULATION. Bagin, V. M. Sov. Astron. AJ (Engl. Transl.); 13: 942-6(May-Jun 1970).
Translated from Astron. Zh.; 46: 1201-6(Nov-Dec 1969).

A model globular cluster is considered that contains several groups of stars of differing mass. If the number of groups is finite, there will be a closed system of equations describing the motion of the stars. In the case where the cluster has only two star groups the system of equations is integrable. The solution obtained for this case implies that the total mass density follows a Schuster distribution and that, at the cluster periphery, the low-mass stars completely displace the high-mass stars. (auth)

30070 DIFFUSE REFLECTION AND TRANSMISSION OF LIGHT BY AN ATMOSPHERE FOR AN ARBITRARY SCATTERING FUNCTION. Sobolev, V. V. (Leningrad Univ.). Sov. Astron. AJ (Engl. Transl.); 13: 893-901(May-Jun 1970).
Translated from Astron. Zh.; 46: 1137-48(Nov-Dec 1969).

The reflection and transmission functions $\rho(\eta,\zeta,\varphi)$ and $\sigma(\eta,\zeta,\varphi)$ are expanded in series with respect to the cosines of multiples of the azimuth angle. The quantities $\rho^m(\eta,\zeta)$ and $\sigma^m(\eta,\zeta)$ appearing in these expansions can be evaluated by three methods: (1) directly from the linear integral equations; (2) by determining the auxiliary functions $\varphi_i^m(\eta)$ and $\Psi_i^m(\eta)$, which are expressed in terms of Chandrasekhar's functions $X^m(\eta)$, $Y^m(\eta)$ and the polynomials $q_i^m(\eta)$, $s_i^m(\eta)$; (3) by determining the functions $X^m(\eta)$, $Y^m(\eta)$ and the polynomials $M^m(\eta,\zeta)$, $N^m(\eta,\zeta)$. The coefficients of these polynomials can be found from systems of linear algebraic equations. The present results generalize those obtained previously for the case $m = 0$. (auth)

30071 SUPERNOVA OUTBURSTS AND THE GENERATION OF RELATIVISTIC PARTICLES. Gurevich, L. E.; Rumyantsev, A. A. (Ioffe Inst. of Physics and Tech., Moscow). Sov. Astron. AJ (Engl. Transl.); 13: 908-13(May-Jun 1970).
Translated from Astron. Zh.; 46: 1158-64(Nov-Dec 1969).

A mechanism for generating relativistic particles in supernova outbursts is discussed. An estimate is made for the acceleration of particles by the radiation emitted after the outburst during the phase of maximum light. The efficiency of the Fermi acceleration mechanism is estimated for the particles injected into the envelope by the radiation. The relativistic protons and electrons in the Crab Nebula are shown to be comparable in abundance. A mechanism is described for generating relativistic electrons in the Crab Nebula. (auth)

30072 PARALLAXES AND PROPER MOTIONS OF 22 STARS. Upgren, A. R.; Mesrobian, W. S.; Nelson, R. M.; Grossenbacher, R.; Kerridge, S. J. (Wesleyan Univ., Middletown, Conn.). Astron. J.; 75: 319-20(May 1970).

The relative parallaxes and proper motions of 22 stars are given,

ten of which have no previous trigonometric parallax determination. All are faint red dwarfs found spectrophotometrically by Vyssotsky. Nine of the stars were measured on the automatic measuring machine of the U. S. Naval Observatory. A substantial improvement in accuracy in both coordinates was found for the stars with automatic measures. (auth)

30073 ATLAS OF LOW-DISPERSION SPECTRA OF S STARS IN THE BLUE REGION. Stephenson, C. B.; Ross, Hazel E. (Case Western Reserve Univ., Cleveland). Astron. J.; 75: 321-3(May 1970).

Published reproductions of S-star spectra in the blue region are rare; to remedy this defect for objective-prism workers, a number of typical S-type spectra are reproduced and it is suggested that AlH be considered as a possible major contributor to the violet opacity in the S and C–S stars, and perhaps in N stars. (auth)

30074 ATTEMPT TO DEFINE LUMINOSITY CRITERIA IN O STARS VIA NARROW-BAND PHOTOELECTRIC PHOTOMETRY. Landolt, Arlo U. (Louisiana State Univ., Baton Rouge. Kitt Peak National Observatory, Tucson, Ariz.). Astron. J.; 75: 337-44(May 1970).

Narrow-band photoelectric indices were defined at the N III triplet λλ4634, 4640, 4641 and at He II λ4686 for 156 O and Of stars. There is some slight indication that the indices defined are sensitive to luminosity. If true, the VI Cygni association is much nearer than previously thought. Comments are made concerning variability of these spectral features. (auth)

30075 DI CAR: A CEPHEID? Seggewiss, Wilhelm (Univ., Bonn). Astron, J.; 75: 345-6(May 1970).

New photoelectric data of the variable star DI Car lead to the conclusion that it is a Cepheid, possibly of Population II, instead of an RW Aur variable as previously supposed. The period is 29.210 days. (auth)

30076 Hα PHOTOGRAPHY OF THE ORION NEBULA WITH A HALF-ANGSTROM FILTER. Fisher, Richard R.; Williamson, Ray A. (Univ. of Hawaii, Honolulu). Astron. J.; 75: 347-50(May 1970).

The Orion Nebula was photographed at a number of wavelengths near the Hα line with a filter of half-width at half-maximum transmission of 9.47 Å. The equipment consisted of a 61-cm $f/15$ reflecting telescope, a Zeiss tunable birefringent filter, and a system of reducing optics to convert the effective focal ratio of the telescope to $f/3.75$. Structural differences in the nebula are revealed on examination of filtergrams obtained at different wavelength settings of the filter. Bright knots, condensations, and sharp intensity gradients are visible at different positions in some of the filtergrams. Many of these features do not appear in a wider-bandpass filtergram (10 Å) of the same region. A Doppler-velocity image, constructed from the photographic subtraction of pairs of filtergrams, is also presented. (auth)

30077 ERRATUM: MK CLASSIFICATIONS FOR F- AND G-TYPE STARS. II. Harlan, E. A.; Taylor, D. C. (Univ. of California, Santa Cruz). Astron. J.; 75: 507-8(May 1970).

MK spectral classifications are given for 166 stars of HD types F2–G5, and having $m_V = 7.5$ or brighter. The classifications were made on slit spectrograms of dispersion 75 Å/mm. (auth)

30078 THEORY AND OBSERVATION OF NORMAL STELLAR ATMOSPHERES. Proceedings of the Third Harvard–Smithsonian Conference on Stellar Atmospheres, Cambridge, Massachusetts, April 8–11, 1968. Gingerich, Owen (ed.). Cambridge, Mass.; Massachusetts Institute of Technology Press (1969). 485p. $15.00. (CONF-680471).

The principal review papers include properties of synthetic spectra and their sensitivity to uncertainties of the physical theory, empirical basis of quantitative spectral classification, comparison of synthetic spectra with real spectra, and astronomical problems influencing the selection of parameters for model stellar atmospheres. The book contains physical and spectral data for a reference set of 68 stellar atmospheres in the effective temperature range from 4000 to 50,000°. (W.D.M.)

30079 FINDING LIST OF LATE-TYPE STARS IN REGIONS OF INTERMEDIATE GALACTIC LATITUDE. Upgren, A. R.; Staron, R. T. (Wesleyan Univ., Middletown, Conn.). Astrophys. J., Suppl. Ser.; 19: No. 178, 367-86(May 1970).

This paper continues a survey of four regions of intermediate galactic latitude. A catalog is given of all stars later than spectral class F2; the earlier stars have already been published. The limiting magnitude is about 11.5. Results are presented in the form of star counts. The importance of the giant stars in the catalog is discussed with respect to the problem of the law of galactic force and the inclination to the galactic plane of layers of equal stellar density. (auth)

30080 PLANETARY NEBULAE. XIII. Aller, Lawrence H. (Univ. of California, Los Angeles). Sky Telesc.; 39: 368-70 (Jun 1970).

A comparison is made, between the Wolf–Rayet stars and the central stars of planetary nebulae. Spectra of Eta Carinae and R R Telescopii are shown. (W.D.M.)

Quasi-Stellar, Radio, and X-Ray Sources

30081 OVER-ESTIMATION OF THE FLUX DENSITY OF WEAK RADIO SOURCES. Murdoch, H. S. (Univ. of Sydney). Proc. Astron. Soc. Aust.; 1: 233-4(Mar 1969).

The over-estimation of the flux density of radio sources near the lower limit of a survey has often been considered in the past. The use of digital recording and analysis techniques now enables a quantitative approach to the problem. Monte Carlo techniques may be used to determine the error distribution, including any systematic bias. Some general features of the problem are considered. (W.D.M.)

30082 FLUX DENSITY MEASUREMENTS OF RADIO SOURCES AT 408 MHz. Wyllie, D. V. (Univ. of Sydney). Proc. Astron. Soc. Aust.; 1: 234-5(Mar 1969).

The flux densities of 220 radio sources were accurately measured at 408 MHz in order to provide a useful set of calibration sources accessible to southern radio astronomers. The flux densities are based on a scale defined by absolute measurements. This scale appears to be 10% higher than the commonly accepted CKL scale and about 8% higher than the scale defined by Kellermann when averaged over common sources. (W.D.M.)

30083 EXTENSION OF CELESTIAL X-RAY SPECTRA TO HIGHER PROTON ENERGIES. McCracken, K. G. (Univ. of Adelaide). Proc. Astron. Soc. Aust.; 1: 236(Mar 1969).

Recently, Clark, et. al. (Ap. J., 153: L203(1968)) observed significant γ-ray fluxes for $h\nu \gtrsim 70$ MeV from the general vicinity of the galactic center. Their angular resolution was too broad to permit detailed comparison with the more accurate measurements at lower energies (≈100 keV). The proposition that the observed emission at >70 MeV is associated with the emissions observed near 100 keV is considered. (W.D.M.)

30084 NEW X-RAY OBJECT AT HIGH GALACTIC LATITUDE. Barnden, L. R. (Univ. of Adelaide); Francey, R. J. Proc. Astron. Soc. Aust.; 1: 236-7(Mar 1969).

Evidence is presented for the existence of a previously unobserved x-ray source in the constellation Cetus. The astronomical significance of an intense x-ray object located so far from the galactic disk is considered. (W.D.M.)

30085 TIME VARIATION OF THE RADIO EMISSION FROM SCO X-1. Ables, J. G. (Univ. of Adelaide). Proc. Astron. Soc. Aust.; 1: 237-40(Mar 1969).

The radio object associated with Sco X-1 was obtained at 6 cm with the 210-ft Parker telescope. The large antenna aperture and low noise temperature allowed measurements statistically superior to all previous ones to be made with an integration time short enough to test for the possibility of intensity–time variations similar to some of those observed in photometric measurements of the optical counterpart of Sco X-1 and having characteristic time scales of tens of minutes to several hours. The position of the source was accurately determined to within a fraction of the antenna beamwidth. (W.D.M.)

30086 THE DEVELOPMENT OF UAT ROCKET INSTRUMENTATION FOR X-RAY ASTRONOMY. Francey, R. J. (Univ. of Tasmania, Hobart, Australia); Fenton, A. G.; Fenton, K. B.; Cooke, D. J.; Barnden, L. R.; Doherty, L. E.; Gregory, A. G.; McCracken, K. G.; Tuohy, I. R. Proc. Astron. Soc. Aust.; 1: 240-2(Mar 1969).

In four experiments on British Skylark rockets, x-ray detectors up to 2100 cm^2 sensitive area have given information on new sources of x rays, variations in intensities and spectra of known and new discrete sources, and the nature of the diffuse x-ray flux. The detectors are gas-filled proportional counters with thin windows of beryllium or organic films. The aims of the experiments and the techniques used are discussed in relation to the fourth flight scheduled for December 1968. (Australia)

30087 IMPROVED STATISTICAL PARAMETERS FOR THE OPTICAL VARIABILITY OF THE QUASAR 3C 273. Ozernoi, L. M.; Chertoprud, V. E.; Chuvakhin, S. D. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 13: 1029-31(May-Jun 1970).

Translated from Astron. Zh.; 46: 1317-19(Nov-Dec 1969).

The revised data obtained from photographic observations of the quasar 3C 273, smoothed over 100-day intervals, are analyzed by

a method similar to that described previously. There is little change in the numerical values of the statistical parameters for the optical variability. Thus all the previous qualitative conclusions, including the inference that a quasiperiodic variability component exists, remain completely valid. (auth)

30088 FARADAY ROTATION IN PULSARS AND THE INTERSTELLAR MEDIUM. Lotova, N. A. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 13: 914-17(May-Jun 1970).

Translated from Astron. Zh.; 46: 1165-8(Nov-Dec 1969).

The following experimental results are discussed: the systematic drift in the position angle of the polarization plane and the variations in the polarization of the radiation of pulsars during the pulse emission time, and the statistical polarization variations within the fine structure of a pulse with a time scale $\tau \approx 10^{-4}$ sec. It is shown that all these effects may arise near the source. In many cases it is important to consider the Faraday rotation in the corona of the source when estimating the magnetic field of the interstellar medium. (auth)

30089 OHIO SURVEY BETWEEN DECLINATIONS OF 0^0 AND 36^0 SOUTH. Ehman, J. R.; Dixon, R. S.; Kraus, J. D. (Ohio State Univ., Columbus). Astron. J.; 75: 351-506(May 1970).

A 1415-MHz continuum survey with the OSU 260- × 70-ft radio telescope was made between declinations of 0° and 36° south covering 7765 deg^2 of sky. Results are presented by maps of the region surveyed and by a list of 4550 sources above 0.16 f.u. Of these sources, 3354 are previously uncatalogued. (auth)

30090 A CATALOGUE OF 3235 RADIO SOURCES AT 408 MHZ. Colla, G.; Fanti, C.; Fanti, R.; (and others) (National Radio Astronomy Lab., Bologna). Astron. Astrophys., Suppl. Ser.; 1: No. 3, 281-317(Mar 1970).

The catalog lists 3235 radio sources observed at 408 MHz with the Bologna Northern Cross telescope. It covers an area of 0.44 sterad between declinations +34°02′ and +29°18′, and is complete down to 0.2 flux units. (auth)

30091 SURVEYS OF THE GALACTIC PLANE AT 1,414, 2.695, AND 5.000 GHZ. Altenhoff, W. J. (National Radio Astronomy Observatory, Green Bank, W. Va.); Downes, D.; Goad, L.; Maxwell, A.; Rinehart, R. Astron. Astrophys., Suppl. Ser.; 1: No. 3, 319-55(Mar 1970).

New surveys of the galactic plane, covering galactic longitudes $l^{II} = 335°$ to 75° and latitudes $b^{II} = -4°$ to +4°, were made in the radio continuum at 1.414, 2.695, and 5.000 GHz. The antennas used for the surveys had diameters of 300, 140, and 85 ft, respectively, and the antenna half-power beamwidths in each case were of the order of 11′. The data are presented in the form of contour maps, together with a tabulation of 356 radio sources. (auth)

Solar Phenomena

Refer also to abstracts 30176, 30181, and 30262.

30092 (AD-702493) PREDICTION OF THE CORONAL STRUCTURE FOR THE SOLAR ECLIPSE OF MARCH 7, 1970. Schatten, Kenneth H. (California Univ., Berkeley. Space Sciences Lab.). 4 Mar 1970. Contract N00014-69-A-0200-1016. 8p. CFSTI.

The coronal structure for the solar eclipse of March 7, 1970 is predicted, utilizing a model of coronal magnetic fields. (USGRDR)

30093 IDENTIFICATION AND CLASSIFICATION OF THE $3p^63p-3p^53d4s$ TRANSITIONS IN Co IX, Ni X, AND Cu XI. Hoory, S. (Hebrew Univ., Jerusalem); Goldsmith, S.; Fraenkel, B. S.; Feldman, U. Astrophys. J.; 160: 781-4(May 1970).

The identification and classification of the $3p^63d-3p^53d4s$ transitions are extended from Fe VIII to Cu XI. (auth)

30094 CORRELATIONS BETWEEN THE ELEMENTS OF THE EVEN 11-YEAR CYCLES OF SOLAR ACTIVITY. FORECAST FOR CYCLE NO. 20. Bonov, Angel D. Izv. Sekts. Astron., Bulg. Akad. Nauk.; 3: 9-17(1969). (In Russian).

Several empirical formulae are established between the elements of the 11-year cycles, with even numbers according to the Zürich numeration, which are not valid for the 11-year cycles with uneven numbers. The difference between the even and uneven 11-year cycles should be taken into account in preparing forecasts for solar activity. Applying the formulae obtained to the current 11-year cycle No 20, the following facts are obtained: the epoch of maximum, 1968, 4 years; Wolf's relative number in the epoch of maximum, 128; and the end of this cycle, 1974, 6 years. (Abstr. Bulg. Sci. Lit.)

30095 EVALUATION OF THE STRUCTURE OF THE SOLAR CORONA ON THE BASIS OF THE FEBRUARY 15, 1961 ROCKET EXPERIMENT. Dmitriev, A. A.; Indzhgia, R. G.; Mikirov, A. E.; Poloskov, S. M. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 190: 803-4(1 Feb 1970). (In Russian).

The brightness distribution in the external corona was determined by means of a rocket-mounted scanning device. The geophysical rocket carrying an electrophotometer with a rectangular slot was launched during the Feb. 15, 1961 solar eclipse; the measurements were made at a height of 100 km above the Earth in order to eliminate scattering effects of the atmosphere. The data were treated at the computer center of the University; it was found that the error was >9.5%. The graphic representation of the results revealed that the structure of the external corona contains separate nonhomogeneous regions at angular distances ranging from 24 to 70 sec. (TTT)

30096 A MECHANISM FOR GENERATING ALFVEN WAVES IN COMETS. Ioffe, Z. M. (Tadzhik State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 13: 1042-3(May-Jun 1970).

Translated from Astron. Zh.; 46: 1328-9(Nov-Dec 1969).

The mechanism responsible for the wave structures in type I comet tails is investigated. It is shown that if these structures are regarded as Alfvén waves, they might arise through Kelvin–Helmholtz (tangential discontinuity) instability at the interface between the cometary plasma and the solar wind. (auth)

30097 TEMPERATURE DETERMINATION IN THE CORONA FROM THE TIME PROFILE OF TYPE III RADIO BURSTS. Fomichev, V. V.; Chertok, I. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 13: 1032-4(May-Jun 1970).

Translated from Astron. Zh.; 46: 1319-21(Nov-Dec 1969).

The need to allow for the extended size of the region where radio emission is generated at a fixed frequency when determining the temperature in the corona from the time profiles of type III bursts is emphasized. It is particularly important to make such an allowance at high frequencies >150 to 200 MHz. (auth)

30098 THE INFLUENCE OF CORPUSCULAR STREAMS ON THE EARTH'S ATMOSPHERIC CIRCULATION. I. THE CHARACTER OF THE AIR-PRESSURE VARIATIONS AT DIFFERENT SEASONS. Mustel, E. R. (Astronomical Council, Moscow). Sov. Astron. AJ (Engl. Transl.); 13: 918-28(May-Jun 1970).

Translated from Astron. Zh.; 46: 1169-83(Nov-Dec 1969).

The main purpose of this investigation was to study how the sign of the ground-level air-pressure variation Δp is distributed over the northern hemisphere after the arrival of a corpuscular stream, or, properly speaking, after the geomagnetic epoch t_m. The problem is discussed for all four seasons. (W.D.M.)

30099 EXCITATION OF HELIUM IN SOLAR PROMINENCES. Morozhenko, N. N. (Central Astronomical Observatory, Kiev). Sov. Astron. AJ (Engl. Transl.); 13: 929-33(May-Jun 1970).

Translated from Astron. Zh.; 46: 1184-9(Nov-Dec 1969).

A comparison of the observed and computed values for the population of the 2^3P level of helium yields the provisional conclusion that in quiescent prominences helium can be excited at the sites of hydrogen emission. The excitation of the metastable 2^3S level of helium results from the ionization–recombination mechanism involving the ionization of helium atoms by ultraviolet solar radiation in the range $\lambda \leq 504$ Å. (auth)

30100 THE OBLATENESS OF THE SUN. Roxburgh, I. W. (Univ. of Sussex, Brighton, Eng.). pp 29-31 of Application of Modern Physics to the Earth and Planetary Interiors. /Runcorn, S. K. (ed.). London; John Wiley and Sons, Inc. (1969).

From Conference on the Application of Modern Physics to the Earth and Planetary Interiors, Newcastle upon Tyne, England. See CONF-670328.

Measurements on the Sun have revealed a difference of 35 km between the equatorial and polar radii, amounting to 5 parts in 10^5 of the radius. The theme of the present paper is to examine whether any effect other than a rapidly spinning core could reasonably be expected to produce the observed oblateness, and in particular whether a slow uniform rotation could be responsible for so large an oblateness. The effect of rotation is usually estimated by considering the ratio of centrifugal force to gravity (d) which for the Sun is only of the order of 10^{-5}. This parameter, however, is not necessarily the correct one for estimating rotational effects. In the convective layers of a star there is a small parameter $\epsilon = (\beta/dTdr)$, where β is the difference between the actual and adiabatic temperature gradients. This parameter is of the order of unity in radiative zones and very small ($\sim 10^{-5}$) in convective zones. The parameter α/ϵ therefore is small in radiative zones but large in convective zones, and it is not unreasonable to expect a slow rotation to have a large effect on a convective layer. A relevant de-

tailed analysis is not available, however, and there is no satisfactory theory of turbulent convection without rotation. As a first approach the theory of the onset of convection is considered, and an expression is derived for the difference in the superadiabatic gradient between the pole and equator ($\Delta\beta$). In the outer layers of the Sun $\Delta\beta$ is found to be $\sim 10^{-8}$. A more reasonable estimate of $\Delta\beta$ would be obtained, however, from the eddy conductivity and viscosity in the convective layer, which is difficult to estimate. If it is assumed that elements formed at the top of the Sun rapidly become isolated from their surroundings and fall freely under gravity, then a value $\Delta\beta = 2.5 \times 10^{-7}$°K/cm can be obtained. A still more realistic value (2×10^{-9}) can be obtained from detailed integrations of the solar outer layers. Such values, however, cannot be considered exact, but if it is assumed that the values are of the correct order of magnitude it can be calculated that the difference between polar and equatorial radius is 30 km. Thus an oblateness of this order may well be produced by the interaction of rotation with turbulent convection. 3 references. (UK)

30101 ION-TEMPERATURE ANISOTROPIES AND STRUCTURE OF THE SOLAR WIND. Eviatar, Aharon (Tel-Aviv Univ., Israel); Schulz, Michael. Planet. Space Sci.; 18: 321-2(Mar 1970).

The introduction of a kinetic equation for the interplanetary medium makes possible a quantitative test of several recently proposed mechanisms for limiting ion-temperature anisotropies in the solar wind. The results suggest that Coulomb collisions and an ion-cyclotron instability contribute comparably to the establishment of this limit under solar-wind conditions usually observed. Conditions favorable to the firehose instability seem to occur only on rare occasions. (auth) (UK)

30102 THE OBLIQUE SHOCK OF THE PROTON FLARE OF JULY 7, 1966. Greenstadt, E. W. (Space Sciences Lab., Redondo Beach, Calif.); Green, I. M.; Inouye, G. T.; Sonett, C. P. Planet. Space Sci.; 18: 333-47(Mar 1970).

The proton flare of July 7, 1966 initiated a shock in the solar wind that arrived at the Earth on the 8th, and was observed by three satellite magnetometers on Explorer 33, Imp 3, and Vela 3A, all outside the magnetosphere. The positions of the three spacecraft and the times of shock observation combine to give a kinematically determined local shock normal pointing 65 to 70° below the ecliptic plane at solar ecliptic longitude 165°. The sense of obliquity of the shock is consistent with the position of the flare in the heliographic northwest quadrant. The high degree of obliquity to the ecliptic suggests a tongue-shaped shock possibly caused by the horizontal configuration and/or high latitude of the flare. (auth) (UK)

30103 MAGNETICALLY ALIGNED FLOWS BETWEEN SUNSPOTS. Meyer, F.; Schmidt, H. U. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Angew. Math. Mech.; 48: No. 8 and Special Issue, T218-21(1968). (In German). (CONF-680469-2).

From Scientific Conference on Applied Mathematics and Mechanics, Prague, Czechoslovakia.

Pressure variations in the photosphere drive flows along connected field line arcs. The flow behavior in a flux tube of magnetic lines is illustrated graphically. Model calculations of these flows in the solar atmosphere were made; typical results for variations of velocity, density, and pressure in a typical magnetic arc are given. The pressure decreases along the ascending side almost exponentially and sinks to the critical cross section. The further course of the curve depends on the pressure at the lower flux point. The flow pushes it through a collision front at a suitable height. The density shows a similar pattern and the velocity behavior is about reciprocal to the density. The temperature distribution is shown by the sound velocity. The relation of the Mach number at the initial point with the apex height of the flux tube is shown. A model is given for the Evershed flow and discussed. The observed reversal of the flow direction can be explained in the model given by the lower pressure and temperatures in the central umbra, in which the higher-lying magnetic tubes must end. Velocity ranges measured in small and young sunspots are in qualitative agreement with the model calculations. (J.S.R.)

30104 NEUTRINO ASTRONOMY OF THE SUN. PART I. NEUTRINO PRODUCTION. Kuchowicz, B. Postepy Astron.: 18: 149-74(Apr 1970). (In Polish).

This is the first part of an up-to-date survey of solar neutrino astronomy. Properties of the neutrinos are summarized together with a short historical outline of development of the neutrino research. Various neutrino sources (occurring in nature and artificial) are presented and a detailed discussion of the thermonuclear reactions as neutrino sources in the main-sequence stars is given. The extremely weak interaction of the neutrino with matter makes it an especially suited probe for stellar interiors. (auth)

Galaxies

30105 STUDIES OF LOCAL STAR STREAMS. II. THE URSA MAJOR STREAM. Ogorodnikov, K. F.; Latyshev, I. N. (Leningrad Univ. Observatory). Sov. Astron. AJ (Engl. Transl.); 13: 934-41(May-Jun 1970).

Translated from Astron. Zh.; 46: 1190-1200(Nov-Dec 1969).

The stars in the solar neighborhood moving like the Ursa Major cluster were investigated. There are several times as many such stars as would be expected from ellipsoidal velocity-distribution theory. The existence of the Ursa Major stream is thereby confirmed. The space density of the stream in the solar neighborhood is 0.0025 star/pc^3; the total number of stars in the stream is 2000 or even more. There are significant differences between the Hertzsprung–Russell diagrams for the Hyades and UMa streams. The UMa stream is younger than the Hyades stream. The galactic orbits of the streams are determined. In both cases the eccentricity is small, rendering it unlikely that the streams originated in regions close to the galactic center. (auth)

30106 THE MILKY WAY IN THE RANGE $l^{II} = 20.8$ TO 32.8° AT 21.1 CM. Ariskin, V. I.; Berulis, I. I.; Sorochenko, R. L. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 13: 902-7(May–Jun 1970).

Translated from Astron. Zh.; 46: 1149-57(Nov–Dec 1969).

The region of the Galaxy in the longitude range $l^{II} = 20.8–32.8°$ was observed at 21.1-cm wavelength both in the neutral-hydrogen line and in the continuum, using the 22-m radio telescope at the Lebedev Physics Institute. A catalog of the radio-line profiles obtained and isophotes for the brightness distribution of the radio line and the continuum in this region of the Milky Way are presented. (auth)

30107 THE INFRARED BRIGHTNESS OF THE MILKY WAY. Sharov, A. S. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 13: 947-52(May-Jun 1970).

Translated from Astron. Zh.; 46: 1207-14(Nov-Dec 1969).

A revised determination is made of the infrared brightness of the Milky Way. The brightness in the galactic-center region is shown to be $\approx 10^{-3}$ erg·cm^{-2}·sec^{-1}·sr^{-1}, and toward the anti-center, 10^{-4} in the same units, for $\overline{\lambda} = 9750$ Å and $\Delta\lambda = 1500$ Å. (auth)

30108 LUMINOSITY FUNCTION OF FIELD GALAXIES. Arakelyan, M. A.; Kalloglyan, A. T. (Byurakan Astrophysical Observatory, Erevan). Sov. Astron. AJ (Engl. Transl.); 13: 953-6(May-Jun 1970).

Translated from Astron. Zh.; 46: 1215-19(Nov-Dec 1969).

A luminosity function for galaxies not belonging to rich clusters is derived from data for galaxies with known radial velocities or photometric distance moduli. The logarithmic luminosity function is represented by three line segments. A comparison of the integrated luminosity functions for field galaxies and rich-cluster members indicates that the ratio of the number of bright galaxies in rich clusters to the number of field galaxies increases with luminosity. (auth)

30109 DISTRIBUTION OF CLUSTERS OF GALAXIES. Gusak, A. I. Sov. Astron. AJ (Engl. Transl.); 13: 964-7(May-Jun 1970).

Translated from Astron. Zh.; 46: 1231-5(Nov-Dec 1969).

The distribution of galaxy clusters is analyzed statistically on the basis of Vols. I and II of Zwicky's catalog. The results indicate that second-order galaxy clusters do exist. Positions are given for several possible second-order clusters. (auth)

30110 THE TIDAL EFFECT AND THE FORMATION OF BARS AND TAILS IN GALAXIES. I. TIDAL FORMATION OF LINEAR BRIDGES BETWEEN GALAXIES. Tashpulatov, N. (Leningrad Univ.). Sov. Astron. AJ (Engl. Transl.); 13: 968-76(May-Jun 1970).

Translated from Astron. Zh.; 46: 1236-46(Nov-Dec 1969).

The outflow of material from the vertex of a homogeneous prolate galaxy due to the close approach of another galaxy is treated hydrodynamically. The "perturbed" galaxy is assumed to be a homogeneous Roche-type prolate ellipsoid; the "perturbing" galaxy, a point mass. The relative orbit of the point galaxy is assumed parabolic, with peri-center distance q. Orbits of individual hydrodynamic mass elements and isochrone curves for their instantaneous positions are computed numerically for two values of the mass ratio of the galaxies and three values of q. It is shown that nearly straight and short "bridges" between the galaxies can form if q is sufficiently small. (auth)

30111 BRIGHTNESS SEGREGATION AND THE BACKGROUND DENSITY IN GALAXY CLUSTERS. Gorbachev, B. I. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 13: 1035-8(May-Jun 1970).

Translated from Astron. Zh.; 46: 1321-4(Nov-Dec 1969).

Counts reported in the literature for the galaxy clusters in Coma Berenices, Cancer, and Perseus and the clusters Hydra 1 and Zw 97-8 are used to derive surface distributions for the number density of member galaxies and to compute the space densities. The influence upon the cluster characteristics of the accuracy of the background estimate is examined. The ratio of the space density of bright and faint clusters is found to increase with the cluster population. For three of the clusters, no similarity is found in the behavior of the space-density ratio for different colors. (auth)

30112 THE ORIGIN OF GALAXIES. Rees, Martin J.; Silk, Joseph. Sci. Amer.; 222: No. 6, 26-35(Jun 1970).

The size, shape, and other properties of the observed galaxies are traced to slight density enhancements in the expanding primordial fireball. Enhancements of certain mass were favored over others. (auth)

30113 UBV PHOTOELECTRIC PHOTOMETRY IN FOUR SOUTHERN MILKY WAY FIELDS. Wooden II, William H. (Case Western Reserve Univ., Cleveland). Astron. J.; 75: 324-36(May 1970).

Three-color observations in the UBV system define photoelectric sequences in four southern Milky Way fields, LF 11, 12, 13, 14 with centers shown. Each of the sequences consists of predominantly main-sequence A, main-sequence F, and giant K stars. The sequences contain the following number of stars and ranges in V magnitude: LF 11, 103 stars with $7.58 < V < 12.70$; LF 12, 152 stars with $8.09 < V < 13.54$; LF 13, 164 stars with $6.52 < V < 13.65$; and LF 14, 161 stars with $8.43 < V < 13.12$. (auth)

Cosmology

30114 CONSIDERATIONS FROM COSMOLOGY AND GALACTIC STRUCTURE WHICH SUGGEST A SECULAR CHANGE IN G. Gilbert, C. (Univ. of Newcastle upon Tyne, Eng.). pp 9-18 of Application of Modern Physics to the Earth and Planetary Interiors. /Runcorn, S. K. (ed.). London; John Wiley and Sons, Inc. (1969).

From Conference on the Application of Modern Physics to the Earth and Planetary Interiors, Newcastle upon Tyne, England. See CONF-670328.

The age of the Universe (T), measured in terms of an atomic unit of time, gives a number of order of magnitude 10^{40}, and application of Dirac's principle leads to the result that the gravitational constant (G) is not in fact a constant but varies inversely with T. It was similarly deduced that Hubble's constant (H) and the mean density of matter in the Universe are quantities varying as T^{-1}. In the theories of Jordan and Brans and Dicke, G is also a quantity that varies with the epoch, although these theories are not so specific about the form of the dependence on T. Since one of Dirac's relationships concerns the value of the mean density of matter in the Universe, any attempt to derive the relationships from the general theory of relativity is dependent on using the "energy-tensor" form of the field equations, and this form contains a constant κ that can be shown to have the value $8\pi G/c^4$, which implies that G is a constant. This indicates a need to reformulate the field equations of the general theory of relativity if the results deduced from Dirac's principle are to be within the scope of that theory. It is also necessary to modify the principle of equivalence, and it is noted that a theory which can account for varying G must have a structure essentially different from the general theory of relativity. Jordan's theory is based on projective relativity, and can account for varying G in accordance with Dirac's hypothesis, but leads to nonconservation of mass. The theory of Brans and Dicke is based on a weak form of the principle of equivalence and allows conservation of mass. Although these theories permit a varying G, the form of variation with T does not necessarily approximate that derived from Dirac's hypothesis. Einstein and Strauss showed that a local gravitating system could not appear to be affected to any appreciable extent by the distant matter of an expanding Universe, but a diminishing value of G in an expanding Universe would be in accordance with the principle that the inertial masses in a local system depend on the distribution of matter in the Universe. The equations of Newtonian cosmology are derived and some of the results obtained from relativistic cosmology are stated. Although the equations of relativistic cosmology are analogous to those of Newtonian cosmology the analogy exists only in general relativity in the local coordinate systems of observers. An outline is also given of a relativistic theory for a cosmology having equations analogous to those of Newtonian cosmology, but with the standard measure of length based on the unit of spatial coordinates, when the usual "cosmic coordinates" are used. In this theory the value of G varies with time. 20 references. (UK)

30115 COSMOLOGIST LOOKS AT THE HYPOTHESIS OF A CHANGE IN THE GRAVITATIONAL CONSTANT. McVittie, G. C. (Univ. of Illinois, Urbana). pp 19-28 of Application of Modern Physics to the Earth and Planetary Interiors. /Runcorn, S. K. (ed.). London; John Wiley and Sons, Inc. (1969).

From Conference on the Application of Modern Physics to the Earth and Planetary Interiors, Newcastle upon Tyne, England. See CONF-670328.

A commentary is presented on certain theories which contain the hypothesis that the "constant of gravitation" (G) is in fact a variable. Amongst topics considered are the quasi-Newtonian gravitational theory, quasi-Newtonian cosmology, relativistic theories, dependence of the universal gravitation function (F) on the physical situation, the Brans-Dicke "empty case," and comparisons with Einstein's general relativity. It is contended that Newtonian gravitational theory is mathematically compatible with a universal gravitation function F, which is a function of absolute Newtonian time alone but there is no prescription for selecting the functional form of F. The theory of orbits in the solar system and of double stars, the dynamics of globular clusters and of the Galaxy, the theory of stellar structure, etc., must be recalculated for an infinity of F functions. In each case the predictions so obtained would have to be shown to be observable and also to be confirmed by observation, and it would be insufficient to argue that a variable F was acceptable because it produced only certain effects. The relativistic theories make F a function of four coordinates, the time and the three space coordinates, and it is conjectured that a different law of gravitation (different function of F) is predicted for the interior of the Earth, for the Earth's orbital motion round the Sun, for the motion of the Sun in the Galaxy, for the cosmological problem, etc. Such laws of gravitation are not superposable because of the nonlinearity of the field equations. It is considered the responsibility of the propounders of theories to show whether such a conjecture is correct or not. It also needs to be explained why such a remarkable degree of agreement with observation had been obtained during the past 300 years through the assumption that there was one universal and constant function F. 14 references. (UK)

30116 DIRAC'S PRINCIPLE OF COSMOLOGY AND RADIOACTIVE DATING. Kanasewich, E. R. (Univ. of Alberta, Edmonton); Savage, J. C. pp 35-45 of Application of Modern Physics to the Earth and Planetary Interiors. /Runcorn, S. K. (ed.). London; John Wiley and Sons, Inc. (1969).

From Conference on the Application of Modern Physics to the Earth and Planetary Interiors, Newcastle upon Tyne, England. See CONF-670328.

It is stated that a test of Dirac's principle of cosmology (Proc. Roy. Soc. London, A, 165: 199(1939)) is very difficult. The year-to-year effects of the principle are so small, at least at the present epoch, that no experiment has been proposed that will detect them. Furthermore, knowledge of the remote past is so imperfect that identification of discrepancies that might be produced by Dirac's principle would be extremely difficult. It is considered that recent determinations (Can. J. Phys., 44: 3033(1966)) of the ^{87}Rb decay constant by mass spectrometric measurement of the amount of ^{87}Sr formed during a seven-year period is critical to the discussion presented, being strong evidence in support of the Rutherford theory in which λ is constant. It is likely that the Rb-Sr ages of terrestrial samples systematically tend to be low due to loss of radiogenic Sr by diffusion, but there is reason to believe that the Rb-Sr age of meteorites is less affected by such an error. If these assumptions are correct, a curvature would be introduced into the line representing β against α and this would be in the same sense as that introduced by Dirac's principle, and it would follow that the analysis presented would be biased in favor of the Dirac theory. In spite of this, the analysis favors the Rutherford theory. Conversely, the result that the Rutherford theory is favored by the analysis suggests that the systematic errors are minor, and confidence is given to the analysis. It is pointed out that the analysis presented follows only the most straightforward development of Dirac's principle, and it is possible that the four coupling constants (strong, electromagnetic, weak, and gravitational) are not all independent. In that case other forms of Dirac's theory become possible. The present analysis offers no support for the Dirac theory of β decay, but the use of the theory of errors, with the implicit assumption of a normal distribution for the errors, in an analysis in which many of the parameters are highly uncertain, must be treated with reservation. All that can be concluded is that the Rutherford theory appears more consistent with the data than the Dirac theory and that this obtains in spite of a

suspected systematic error that favors the latter theory. 49 references. (UK)

30117 PALAEONTOLOGICAL METHOD OF TESTING THE HYPOTHESIS OF A VARYING GRAVITATIONAL CONSTANT. Runcorn, S. K. (Univ. of Newcastle upon Tyne, Eng.). pp 47-51 of Application of Modern Physics to the Earth and Planetary Interiors. /Runcorn, S. K. (ed.). London; John Wiley and Sons, Inc. (1969).

From Conference on the Application of Modern Physics to the Earth and Planetary Interiors, Newcastle upon Tyne, England. See CONF-670328.

A discussion is presented regarding the possibility that there may exist geological, geophysical, and astronomical evidence for a variable G. Amongst matters discussed in this connection are continental drift, geological dating, gaps in the geological column, changes in the length of the day and month, changes in the Earth's moment of inertia, growth increments on Devonian corals and in stromatalites and other forms of marine life. Palaeontology as a tool in palaeogeophysics is only at an early stage of investigation, but it is of interest to consider to what problems it might be applied. 15 references. (UK)

30118 ON THE POSSIBILITY OF AVOIDING RAMSEY'S HYPOTHESIS IN FORMULATING A THEORY OF EARTH EXPANSION. Jordan, P. (Univ., Hamburg). pp 55-63 of Application of Modern Physics to the Earth and Planetary Interiors. /Runcorn, S. K. (ed.). London; John Wiley and Sons, Inc. (1969).

From Conference on the Application of Modern Physics to the Earth and Planetary Interiors, Newcastle upon Tyne, England. See CONFf70328.

Dirac in 1937, motivated by considerations regarding cosmology on the one hand, and the physics of elementary particles on the other hand, put forward an hypothesis expressing the idea that the gravitational constant G might in reality not be a constant but a physical value slowly decreasing in the ccurse of cosmological evolution. The present author studied the question of how Einstein's theory of gravitation might be revised or generalized if Dirac's hypothesis was to be correct. Dirac's decrease of G, if it existed, must have caused a marked expansion of the Earth in the course of its history. A question discussed is what cause may have been in action since the carboniferous era giving, in addition to the elastic expansion, another about ten times stronger contribution to the expansion process. According to the Ramsey hypothesis the material of the outer core is not chemically different from that of the mantle, but is a denser phase of the mantle material. It therefore seemed attractive to consider that perhaps at the beginning of the Earth's history there was scarcely any mantle beneath the sial layer, and that this absence continued during several thousand million years, the expansion during this time being only elastic. Subsequently, the chief part of the expansion was due to the phase change, the core material being transformed to mantle material. It was found, however, that the Ramsey hypothesis must be abandoned, and the question arose as to whether the findings could be maintained without using Ramsey's concept. It could have been that for a certain time the mantle could have grown by crystallization of matter originally dissolved in the fluid core. The strong expansion during the geological ages since the carboniferous would then be attributed to the segregation of dissolved material from the core. 19 references. (UK)

30119 SEARCH FOR ^{3}He IN DEEP-SEA BASALTS. Fisher, David E. (Univ. of Miami, Fla.). Earth Planet. Sci. Lett.; 8: 77-8(Mar 1970).

Results of a search for an ^{3}He component in rocks with high ^{4}He/^{40}Ar ratios are presented. The measurements were made on a glass Reynolds-type 4.5-inch, 60° rare gas mass spectrometer. A limit of 10^{-10} STP/g ^{3}He was found. (W.D.M.)

30120 REDSHIFT AND EPOCHS IN A GENERALIZED FRIEDMANN AND LEMAITRE COSMOLOGY. Ionescu-Pallas, N. J. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 14: 1105-9(1969).

Einstein's gravitational equations are solved under the following circumstances: (1) the metrics are conformally flat; (2) the perfect fluid scheme does hold; (3) the cosmical pressure may be neglected; and (4) the cosmological constant is related to intrinsic geometry of empty space-time and has a negative value. The presence of matter yields a zero in metrics, while the cosmological constant is responsible for the appearance of a singularity in the same metrics. However, the singularity is never reached, because it corresponds to an infinite cosmical epoch. Finally, the redshift formula is derived in the framework of the assumed model. (auth)

30121 GRAVARS. Kafka, P. (Max-Planck Inst. for Physics and Astrophysics, Munich). Nature (London); 226: 436-9(2 May 1970).

A discussion is presented on the paper by Weber (Phys. Rev. Lett., 22: 1320(1969)) on the subject of gravitational radiation, and it is concluded that the concept of cosmological origin of this radiation should be abandoned. The large energy density must be a local phenomenon. Some confortable processes in other types of radiation are briefly considered. Large amounts of gravitational radiation can be produced only when masses are close to their Schwarzschild radius and are moving rapidly in a nonspherically symmetric way, such as the collapse of a rotating star towards a "black hole," the collapse of a cluster of stars or a super star or the close passage or fusion of two "black holes" in a dense cluster. A possible explanation put forward is related to the existence of dense clusters of collapsed objects, referred to as "gravars." Gravar evolution will be determined by (a) energy loss through gravitational radiation, (b) evolution of the mass function through fusion of "black holes" in strong collisions, (c) the "classical" evaporation of stars. Numerical analysis of small clusters hints that straining may be accelerated by the influence of the mass function, the building of energy in double and higher systems, and perhaps other effects. Without faster than "classical" evolution no cluster can have reached the gravar region. The lifetime of a gravar will be shorter than the time scale of radiation loss. (UK)

30122 MEASUREMENT OF THE ISOTROPIC BACKGROUND RADIATION IN THE FAR INFRARED. Muehlner, Dirk; Weiss, Rainer (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 24: 742-6(30 Mar 1970).

Measurements made at an altitude of 40 km with a balloon-borne radiometer that has three separate spectral responses in the spectral region below 20 cm^{-1} indicate that the spectrum of the isotropic background radiation may not be thermal. (auth)

Planetary Phenomena

30123 (N-70-11065) RADIATION EFFECTS. Final Report, August 31, 1968-July 31, 1969. Fleischer, R. L.; Price, P. B.; Hart, H. R. Jr.; Woods, R. T. (General Electric Co., Schenectady, N. Y. General Physics Lab.). 11 Sep 1969. Contract NAS9-7898. 67p. (NASA-CR-101979; SC-33-45-(28)). CFSTI.

Work is summarized which is directed at preparation for examination of lunar samples for stored particle tracks of whatever types may be present, whether from internal or external origin. The particle track work falls into six categories: (1) examination and fission-track dating of terrestrial-impact-produced materials; (2) examination and identification of tracks in extraterrestrial materials; (3) improvement in techniques for identification of individual particles in minerals; (4) a search for heretofore unidentified natural tracks; (5) accelerator simulation of cosmic-ray effects in likely lunar mineral types; and (6) study of the effects of heating and of shock on tracks in minerals. (auth) (STAR)

30124 APPLICATION OF MODERN PHYSICS TO THE EARTH AND PLANETARY INTERIORS. Proceedings of Conference Held at Newcastle upon Tyne, England, 29th March-4th April 1967. Runcorn, S. K. (ed.). London; John Wiley and Sons, Inc. (1969). 89p. £13. (CONF-670328).

Forty-eight papers were presented under the following main sectional headings: Cosmology and geophysics; solid-state physics and geophysics; high-pressure physics and the Earth's interior; developments in techniques; magnetohydrodynamics; and the Earth as a fundamental physics laboratory. Separate abstracts are presented for 9 of these papers, considered in scope for NSA. A preface by L. Rosenfeld is included entitled Celestial and Terrestrial Physics in Historical Perspective. (UK)

For abstracts of individual papers see: 30100, 30114-30118, and 30125-30127.

30125 ENERGY CHANGES IN AN EXPANDING EARTH. Beck, A. E. (Univ. of Western Ontario, London). pp 77-83 of Application of Modern Physics to the Earth and Planetary Interiors. /Runcorn, S. K. (ed.). London; John Wiley and Sons, Inc. (1969).

From Conference on the Application of Modern Physics to the Earth and Planetary Interiors, Newcastle upon Tyne, England. See CONF-670328.

Possible changes in the gravitational potential energy of the Earth as a whole are discussed, and it is concluded that from considerations of gravitational potential energy alone, neglecting energy sources and sinks, primitive Earth models with plausible density distributions can be found which allow radial expansion of

about 400 km, and, if all the radioactive energy goes into expansion, this would give a further 200 or 300 km expansion. When certain possible restrictions are taken into account, however, this increase may be reduced. In particular, if the moment of inertia of the primitive Earth was much higher than for the present Earth, for instance about 9.0, as suggested by the Birch primitive model and by Runcorn (Nature, 204: 823-5(1964)), this restricts the possible radial increase, using reasonable primitive density distributions, to less than 100 km. It is concluded that on present-day knowledge radial increases of the order of 1000 km seem improbable, but radial increases of the order of 100 km cannot be ruled out. Energy sources and sinks are also briefly discussed. 7 references. (UK)

30126 COSMOGONICAL ASPECTS IN THE THEORY OF PLANETARY INTERIORS. Herezeg, T. (Univ., Hamburg). pp 301-9 of Application of Modern Physics to the Earth and Planetary Interiors. /Runcorn, S. K. (ed.). London; John Wiley and Sons, Inc. (1969).

From Conference on the Application of Modern Physics to the Earth and Planetary Interiors, Newcastle upon Tyne, England. See CONF-670328.

It is stated that cosmogony may give, at best, only "second class" information about the structure and composition of the planets. Information is mainly channeled in the reverse direction, and facts revealed by the physics and chemistry of the planets yield the basic criteria for cosmogonical theory. Nevertheless, planetary cosmogony is advancing very rapidly and seems to be in a sufficiently developed stage to allow an attempt to learn something about planetary interiors on this basis. In the present paper an attempt is made to tackle an important abundance problem in the region of the terrestrial planets in terms of the various hypotheses about their origin and early evolution. Understanding of the so-called "iron anomaly" and accounting for the composition of massive iron cores in terms of cosmogonical considerations turned out to be unexpectedly difficult, and in the studies described the relevent fractionation process was not found. If any conclusions could be drawn, the possibility that the "cosmic" (spectroscopic) abundance of iron has been underestimated is still not to be completely rejected. Solar system data would give more reliable information. If the discussed "iron anomaly" really exists, hope of an explanation is to be placed on recognition that the chemical facts, magnetic and radiative effects, and probably thermal segregation, are insufficient for the explanation. The studies, however, may have led to a better understanding of the composition and structure of Mercury. If the explanation put forward of its high density can be further substantiated, this would be further evidence supporting the general concept of cold dust accumulation. 21 references. (UK)

30127 FISSION TRACK DATING AND PROCESSES IN THE EARTH'S INTERIOR. Fleischer, R. L. (General Electric Co., Schenectady, N. Y.); Price, P. B.; Walker, R. M. pp 499-503 of Application of Modern Physics to the Earth and Planetary Interiors. /Runcorn, S. K. (ed.). London; John Wiley and Sons, Inc. (1969).

From Conference on the Application of Modern Physics to the Earth and Planetary Interiors, Newcastle upon Tyne, England. See CONF-670328.

It is stated that fission-track dating presents extensive and largely untapped opportunities for the dating of thermal, magnetic, and mechanical events in minerals, and the simplicity of the technique makes it an attractive tool for probing the past. The technique depends on the fact that the fragments emitted in the spontaneous fission of ^{238}U can create narrow continuous damage trails in most minerals, and these stored damage sites can be displayed by chemical etching to give tube-like or conical holes of size viewable and countable in an ordinary optical microscope. Since the number of such tracks depends only on the U content and on the time since track storage began, this age can be measured provided the U content can be determined, and the latter can be done by giving the sample a known dose of thermal neutrons in a nuclear reactor and subsequently counting the new fissions (of ^{235}U) induced by the irradiation. The permanence of the tracks depends on the material and its thermal history, and once the response of a particular material to thermal treatments has been calibrated it can be employed to learn about thermal events in the past. Applications to thermal dating, paleomagnetic dating, and the dating of mechanical processes in materials are described. Some measurements involving thermal effects in nature have been made, but the paleomagnetic and paleomechanical opportunities are as yet unexplored. 16 references. (UK)

30128 CHEMICAL COMPOSITION OF THE LUNAR SURFACE IN A TERRA REGION NEAR THE CRATER TYCHO. Patterson, James H. (Argonne National Lab., Ill.); Turkevich, Anthony L.; Franzgrote, Ernest J.; Economou, Thanasis E.; Sowinski, Kenneth P. Science; 168: 825-8(15 May 1970).

More precise and comprehensive analytical results for lunar surface material in a terra region were derived from the data of the alpha-scattering experiment on Surveyor 7. The silicon content and the low sodium abundance are close to that of mare material. The abundances of titanium and iron are at least a factor of 2 lower, whereas the abundances of aluminum and calcium are significantly higher. The analytical results provide direct evidence for chemical differentiation in the Moon and indicate a lunar crust of appreciably lower density than the whole Moon and with lower density and higher albedo than lunar mare material. (auth)

30129 Rb-Sr AGES OF LUNAR ROCKS FROM THE SEA OF TRANQUILLITY. Papanastassiou, D. A.; Wasserburg, G. J.; Burnett, D. S. (California Inst. of Tech., Pasadena). Contract NAS 9-8074. Earth Planet. Sci. Lett.; 8: 1-19(Mar 1970).

$^{87}Rb-^{87}Sr$ internal isochrons were determined for six crystalline rocks from the Sea of Tranquillity, and all yield ages within the narrow range $3.65 \pm 0.06 \times 10^9$ yr. Differences in initial $(^{87}Sr/^{86}Sr)_I$ define at least two main rock groups which coincide with the two groups indicated by alkali content of the rocks. This demonstrates that at least two magnetic reservoirs were involved in the 3.65×10^9 yr event on the Moon. The soil yields a model Rb-Sr age of 4.6×10^9 yr which suggests that it consists of an average over a variety of rock systems of different ages which represent a closed total system 4.6×10^9 yr old or the widespread existence of rocks of 4.6×10^9 yr age. A single peculiar rock fragment from the soil gives a model age of 4.4×10^9 yr. Initial Sr compositions for the lunar rocks and for soil fragments define a narrow range (0.6990 to 0.6994) whose lower limit is equal to the basaltic achondrite initial Sr. The Moon, Earth, and basaltic achondrites represent planets with Rb/Sr much lower than in the Sun. The Moon and the basaltic achondrites must have separated from the solar nebula within a time interval of less than 4×10^8 yr. From consideration of Sr-Rb relations, if the Moon formed by fission from the Earth, it must have occurred prior to 4.4×10^9 yr ago. (auth)

30130 THE ISOTOPIC COMPOSITION OF Gd AND THE NEUTRON CAPTURE EFFECTS IN SAMPLES FROM APOLLO 11. Eugster, O.; Tera, F.; Burnett, D. S.; Wasserburg, G. J. (California Inst. of Tech, Pasadena). Contract NAS 9-8074. Earth Planet. Sci. Lett.; 8: 20-30(Mar 1970).

The isotopic composition of Gd in six rocks, one breccia, two core samples, and soil was determined. Isotopic variations due to capture of low-energy neutrons produced by cosmic-ray interactions were found in all samples except for two rocks. Using cosmic-ray exposure ages, the effective thermal neutron fluxes were calculated using a nominal value of $^{157}\sigma = 2.62 \times 10^5$ barns. They vary from less than 0.27 n/cm^2 sec to 1.1 n/cm^2 sec indicating variable shielding for the samples studied. The neutron dosage of the top and the bottom of core #2 is the same. This means that the soil has been mixed to 13 cm at least once in the last 100 my. A mixing depth of 23 to 47 m can be calculated based on the integrated effective thermal neutron dosage of 9×10^{15} n/cm^2 for the soil and an assumed surface flux of 0.2 n/cm^2 sec. For rock #17 the barium isotopic composition was determined and found to be the same as terrestrial to within 0.1% for the five abundant isotopes. (auth)

Atomic and Molecular Physics

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 29546 and 29609.

30131 (RS-8132/189) A COMPILATION OF MASS ABSORPTION COEFFICIENTS FOR 40 ELEMENTS. Dorety, L. M.; Field, V. M. (Sandia Corp., Livermore, Calif.). May 1966. 60p. Dep. CFSTI.

Mass absorption coefficients for 40 elements are given for the energy range 0.1 keV to 100 MeV. This absorption coefficient data is based on the assumption that half of the scattered photons are transmitted and half are absorbed. Sources used for this compilation include Air Force Weapons Laboratory, Lawrence Radiation Laboratory, and Los Alamos Scientific Laboratory publications. (auth)

30132 (UCRL-50174(Sec.1)) COMPILATION OF X-RAY CROSS SECTIONS. SECTION I. McMaster, W. H.; Del Grande, N. Kerr; Mallett, J. H.; Hubbell, J. H. (California Univ., Livermore. Lawrence Radiation Lab.). Jan 1970. 18p. Dep. CFSTI.

Methods used in compiling x-ray cross sections in the range 1 keV to 1 MeV are described, data are evaluated, and experi-

mental and theoretical cross sections are compared. The actual compilation has been published as UCRL-50174 Sec. II Rev. 1 (NSA 23: 41914). Supporting data used to create the compilation have been published as UCRL-50174 Sec. III (NSA 24: 15149). Cross sections at energies useful to crystallographers are given in UCRL-50174 Sec. IV. (A.G.W.)

30133 ION BEAM DEVICE USING DIFFERENTIAL PUMPING SYSTEM FOR PROCESSING AND PENETRATION RANGE STUDY IN GASEOUS MOLECULES. Shimizu, Keizo (Electrotechnical Lab., Tokyo); Matsui, Shigeo; Kawakatsu, Hisazo; Shimoi, Saburo; Sano, Hisayoshi; Kanaya, Koichi. Denki Shikensho Iho; 33: 1366-82(1969).

An ion beam device was constructed to study ion optical problems, ion processing, and ion penetration characteristics in gaseous molecules. The device consists of a duoplasmatron ion source, an electrostatic lens system, a differential pumping system, a working chamber, and some accessories. The pressure in the working chamber can be varied from the order of 10^{-6} torr to atmospheric pressure, while the other parts of the device are kept in high vacuum. Characteristics of the device and some preliminary experimental results are described. Argon–ion penetration characteristics in air for different accelerating voltages were measured, and the results agree qualitatively with the ranges calculated by Lindhard's theory. (auth)

30134 INFLUENCE OF ELECTRON BEAM INTENSITY ON THE INVERSE POPULATION OF Nd^{3+}-ACTIVATED GLASS LASERS. Arifov, U. A.; Bedilov, M. R.; Khamidov, N.; Khaidarov, K. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 6, 24-6(1969). (In Russian).

The inverse population of the Nd^{3+} admixture in the four-level laser system was studied as a function of the electron beam intensity, which alters the threshold and the quantum yield. The intensity of the electron beam was studied at 0.1 to 1 μA and beam energy varying from 0 to 250 keV. Typical oscillograms are included. The results obtained show that the relative intensity of the quantum yield depends on the amount of absorbed radiation dose and its distribution on the energy range of the particle flux. (R.V.J.)

30135 SPECTRAL LUMINANCE OF A HIGH FREQUENCY ELECTRIC EXCITATION ION SOURCE. Degeilh, Andre; Denizart, Michel; Pilod, Pierre; Soum, Gabriel (Toulouse Univ.). Compt. Rend.; Ser. B; 270: 860-2(1 Apr 1970). (In French).

The spectral luminance of an argon ion beam extracted from a high-frequency ion source was measured. The positive ions are accelerated by a tension of about 20 kV and collected in a Faraday cage from an electrostatic analyzer. The results obtained are similar to those found for a duoplasmatron-type ion source. (France)

30136 SCATTERING OF LOW-ENERGY ELECTRONS BY A THREE-DIMENSIONAL KRONIG–PENNEY POTENTIAL. Pogorel'skii, K. S.; Dvoryankin, V. F.; Mityagin, A. Yu. (Inst. of Radio Engineering and Electronics, Moscow). Sov. Phys.-Solid State (Engl. Transl.); 11: 2614-17(May 1970).

Translated from Fiz. Tverd. Tela; 11: 3225-9(Nov 1969).

The scattering of low-energy electrons is treated by a three-dimensional Kronig–Penney potential. An analytical expression is found for the reflection and transmission coefficients in a many-wave approximation. For the one-wave approximation, it is shown that the width of the Bragg maximum equals the width of the corresponding forbidden band and its position corresponds to the position of this band. It is shown that, for thin crystals, the dependence of the reflection coefficient on the energy of the incident electrons exhibits additional maxima connected with quantum size effects. It is found that inclusion of an internal potential leads to a uniform shift of the band structure in energy by the value of the internal potential. (auth)

30137 THE MEASURED ENERGY LOSS OF HIGH-ENERGY ELECTRONS IN COPPER AND LEAD. Bumiller, F. A.; Buskirk, F. R.; Dyer, J. N. (Naval Postgraduate School, Monterey, Calif.). Z. Phys.; 234: 185-92(1970).

The energy distributions of Linac electrons of about 53, 75, and 93 MeV have been measured before and after passing through copper absorber of thickness up to 5.726 g/cm^2 and lead absorbers of thickness up to 2.825 g/cm^2. Earlier data for aluminum absorbers are reviewed. The most probable energy losses agree with the theory of Blunck and Westphal for all thicknesses; the half widths agree except for large thicknesses, where they are smaller than theoretical values for lead, in agreement for copper, and larger for aluminum. Large numbers of electrons of energy less than 30 MeV are observed in the distributions of transmitted electrons, particularly for thick absorbers and higher values of atomic number. These are apparently the result of multiple processes in the absorbers. (auth)

30138 ENERGY-STRAGGLING MEASUREMENTS OF HEAVY CHARGED PARTICLES IN THICK ABSORBERS. Tschalaer, C. (Rutherford High Energy Lab., Chilton, Eng.); Maccabee, H. D. Phys. Rev., B; 1: 2863-9(1 Apr 1970).

Energy-straggling distributions of 20- and 49-MeV protons and 80-MeV helium ions were measured for energy losses of 10 to 92% of the initial kinetics energy. Aluminum and gold absorbers were used, and the residual energy spectra were measured with lithium-drifted silicon semiconductor detectors. Experimental results show very good agreement with the theories of Payne and Tschalär, provided that broadening due to atomic binding is taken into account, and disagreement with the Bohr theory for energy losses greater than 20%. In particular, as the particle beam slows down in the absorber, the variance of the energy distribution increases faster than the absorber thickness traversed, and a degree of skewness (i.e., a low-energy "tail") is introduced at very large energy losses. (auth)

30139 STRAGGLING OF HEAVY CHARGED PARTICLES: COMPARISON OF BORN HYDROGENIC-WAVE-FUNCTION APPROXIMATION WITH FREE-ELECTRON APPROXIMATION. Bichsel, Hans (Univ. of California, Berkeley). Phys. Rev., B; 1: 2854-62(1 Apr 1970).

Statistical fluctuations in the energy loss of heavy charged particles in thin absorbers resulting from collisions with atomic electrons are determined for collision cross sections obtained from the first Born approximation calculated with hydrogenic wave functions. A comparison is given with the results calculated with a $1/\epsilon^2$ collision spectrum. (auth)

30140 IMPACT-PARAMETER DEPENDENCE OF INNER-SHELL VACANCY PRODUCTION BY HEAVY-ION BOMBARDMENT. Stein, H. J.; Lutz, H. O.; Mokler, P. H.; Sistemich, K.; Armbruster, P. (Kernforschungslage, Juelich, Ger.). Phys. Rev. Lett.; 24: 701-2(30 Mar 1970).

30-MeV I ions were scattered by thin targets of Yb and Te. The differential and total cross sections for characteristic x-ray production were measured. The mechanism responsible for inner-shell ionization is suggested to be electron promotion by level crossing in the quasimolecule of the colliding atoms. (auth)

Atomic and Molecular Properties

Refer also to abstracts 30093 and 30337.

30141 (COO-427-99) ELECTROMAGNETIC SELF-ENERGY OF K-ELECTRONS IN HEAVY ATOMS. Desiderio, A. M.; Johnson, W. R. (Notre Dame Univ., Ind. Dept. of Physics). [1968]. 12p. Dep. CFSTI.

The self-energy of K-electrons in atoms with atomic numbers in the range $74 \leq Z \leq 90$ is determined numerically. Detailed theoretical evaluations of K-electron binding energies including all effects of $O(\alpha\, mc^2)$ are given for three heavy closed-subshell atoms, W, Hg, and Pb. With the present values of the electron self-energy, the theoretical K-shell binding energies for these elements are found to agree with experimental determinations to better than $1/10^4$. (auth)

30142 (NBS-SPEC. PUBL-306-4) BIBLIOGRAPHY ON THE ANALYSES OF OPTICAL ATOMIC SPECTRA. SECTION 4. ^{57}La–^{71}Lu; ^{89}Ac–^{99}Es. Moore, Charlotte E. (National Bureau of Standards, Washington, D. C.). Aug 1969. 55p. GPO $0.55.

This bibliography is intended to include all references to date needed to compile tables of atomic energy levels, classified lines, and Zeeman data for rare earth spectra. A list of general references is included as well as lists of references for each individual element. The content of each paper listed is briefly described by key letters or words. (A.G.W.)

30143 EFFECT OF RECOIL IN THE INTERACTION OF AN ATOM WITH A STRONG FIELD. Vorobev, F. A.; Rautian, S. G.; Sokolovskii, R. I. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 398-401(Nov 1969).

Translated from Opt. Spektrosk.; 27: 728-33(Nov 1969).

The effect of recoil is investigated in the interaction of an atomic system with a strong resonance field, taking into account both induced and spontaneous processes. The velocity distributions at the combining levels and the dependence of radiant power on frequency were found. The spectral characteristics of gas lasers were studied. The phenomena investigated can be observed in lasers with the aid of an absorption cell whose working material has a natural line width on the order of 10^3 to 10^5 sec^{-1}. (auth)

30144 SPECTRAL-KINETIC CHARACTERISTICS OF THE URANYL ION IN GLASS AT HIGH EXCITATION POWER. Bonch-Bruevich, A. M.; Kaliteevskaya, E. N.; Karapetyan, G. O.; Kolobkov, V. P.; Kudryashov, P. L.; Razumova, T. K.; Reishakhrit, A. L. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 433-7(Nov 1969).

Translated from Opt. Spektrosk.; 27: 795-803(Nov 1969).

The spectral kinetic characteristics of absorption and luminescence of the UO_2^{2+} ion in silicate glass at high-power light excitation was studied. The spectrum and cross section of absorption from the metastable state of UO_2^{2+} were measured, the probabilities of relaxation from the upper excited states estimated, and the principal channels of this relaxation determined. The absorption spectra from the ground and metastable states are compared with the classification of terms of the UO_2^{2+} ion obtained from consideration of the point group $D_{\infty h}$. The results obtained are essential for interpretation of the shutter and sensitization effects of the uranyl ion. (auth)

30145 MEASUREMENT OF X-RAY ABSORPTION BY BERYLLIUM, CARBON, AND VARIOUS PLASTICS BETWEEN 4 AND 17.5 A. Senemaud, G. (Laboratoire de Chimie Physique, Paris). J. Phys. (Paris); 30: 811-18(Oct 1969). (In French).

The x-ray absorption coefficients for beryllium and carbon were measured as a function of the wavelength continuously from 8 to 14 Å. The experimental values obtained are compared with various semi-empirical estimations and with the theoretical values obtained from Stobbe's formulas taking account of the screen effects. The transmission of various plastic films was measured at discrete wavelength values between 4 and 17 Å, from which semi-empirical formulas are deduced for the variation of their absorption coefficient in this range. (auth)

30146 PRECISE MEASUREMENT OF ATTENUATION COEFFICIENTS OF γ RAYS IN THE 7.5 MeV REGION. Moreh, R.; Salzmann, D.; Wand, Y. (Nuclear Research Centre, Beer-Sheva, Israel). Phys. Lett.; 30B: 536-7(8 Dec 1969).

A new technique utilizing nuclear resonance scattering of γ rays was used for measuring total attenuation coefficients of 15 elements between Be and U. The γ-ray energies were 7.279 and 7.646 MeV, and the results were found to be generally higher than the calculated values. (auth)

30147 VISIBILITY OF SINGLE ATOMS. Crewe, A. V.; Wall, J.; Langmore, J. (Univ. of Chicago). Science; 168: 1338-40 (12 Jun 1970).

Theoretical and experimental studies indicate that, with a high-resolution scanning electron microscope, it is now possible to obtain pictures of a single heavy atom resting on a thin carbon substrate. (auth)

30148 LIFETIME OF THE 2^1S STATE OF He. Pearl, A. S. (National Research Council of Canada, Ottawa). Phys. Rev. Lett.; 24: 703-5(30 Mar 1970).

A traveling Auger detector is used to measure the attenuation of a cooled thermal beam of He 2^1S atoms in a vacuum of 1×10^{-8} torr. Its velocity is determined by a time-of-flight technique. The lifetime obtained is $(38 \pm 8) \times 10^{-3}$ sec. (auth)

30149 MEASUREMENT OF THE STARK-BROADENING PARAMETERS OF SOME SINGLY IONIZED ARGON LINES. Konjevic, N.; Labat, J.; Cirkovic, Lj.; Puric, J. (Inst. of Physics, Belgrade). Z. Phys.; 235: 35-43(1970).

Half-widths of fifteen Stark-broadened argon II lines were measured in argon plasma behind the reflected shock wave produced in an electromagnetically driven "T" tube. The plasma electron density was determined by the laser interferometry at three different wavelengths, while the plasma temperature was measured from relative intensities of Ar II lines. Temperatures were in the range 8,500 to 16,500°K; electron densities varied from 1.82 to 3.94×10^{17} cm^{-3}. The measured Ar II line widths are compared with theoretical and other experimental results. It is shown that (a) broadening of Ar II lines is in good agreement with the theory, (b) line broadening increases linearly with electron density, and (c) Stark-broadened lines follow the dispersion profile to the distance of at least three half widths from the line center. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 30403, 30478, and 30749.

30150 EXPERIMENTAL AND THEORETICAL STUDY OF THE TOTAL NUMBER OF PHOTONS AND THE PHOTON SPECTRUM OBTAINED IN THE ANNIHILATION IN FLIGHT OF MONOCHROMATIC POSITRONS. Audit, G.; de Botton, N.; Tamas, G.; Beil, H.; Bergere, R.; Veyssiere, A. (CEN, Saclay, France). Nucl. Instrum. Methods; 79: 203-12(1970). (In French).

A computer program was used to calculate the photon spectrum created by the annihilation-in-flight method of monochromatic positrons. Multiple scattering, angular distribution, and energy loss of positrons in the annihilation target are taken into account. Experimental results using different techniques are in good agreement with theoretical evaluations. In particular, it is shown how the reaction $^{28}Si(\gamma,p_0)^{27}Al$ can be used to measure the energy resolution ($\Delta E_\gamma / E_\gamma$) of the "quasi-monochromatic" γ beam in the energy range 6 MeV $\leq E_\gamma \leq$ 40 MeV. (auth)

30151 TO THE THEORY OF MUON DEPOLARIZATION IN MESOATOMS. Tammet, E. V. (Inst. of Cybernetics, Tallin). Yadern. Fiz.; 11: 840-5(Apr 1970). (In Russian).

The effect of the electron shell with noncompensated magnetic moment on muon polarization in mesoatoms with arbitrary nuclear momentum is considered. The system is described by the spin-Hamiltonian $H = AsI + Bs\sigma + G\sigma I$. General and approximated formulas for calculation of muon polarization are obtained. The effect under consideration turns out to be comparable with the effect of nuclear momentum on muon polarization. (auth)

30152 INFLUENCE OF DISPERSION ON POSITRON ANNIHILATION IN METAL OXIDES. Bartenev, G. M.; Varisov, A. Z.; Gol'danskii, V. I.; Levin, B. M.; Mokrushin, A. D.; Tsyganov, A. D. (Moscow State Pedagogical Inst.). Sov. Phys.-Solid State (Engl. Transl.); 11: 2575-9(May 1970).

Translated from Fiz. Tverd. Tela; 11: 3177-82(Nov 1969).

The lifetime of positions was studied in powdered oxides of alkali-earth metals (BeO, MgO, CaO, SrO, and BaO) and in baked beryllium oxide. The angular distribution of the annihilation radiation was studied in BeO, MgO, SiO_2, Al_2O_3, and CaO powders, in Al_2O_3 and SiO_2 single crystals, as well as in baked BeO and MgO. The time spectra of BeO and MgO powders contain the component with $\tau_3 \approx 80$ sec ($I_3 \approx 7.5\%$), while the τ_3 component fails to occur in baked BeO and CaO-BaO powders. The angular distribution in BeO, MgO, SiO_2, and Al_2O_3 powders contains an intense narrow component, which in turn does not occur in monolithic specimens. A discussion of the results obtained is given. (auth)

30153 SEARCH FOR POSITRONIUM LYMAN α-RADIATION FROM POSITRONS STOPPED IN INERT GASES. Leventhal, Marvin (Yale Univ., New Haven). Proc. Nat. Acad. Sci. U. S.; 66: 6-12(May 1970).

An attempt to detect the positronium Lyman-α radiation at 2430 Å is reported. Positrons from an intense ^{64}Cu source (20 Ci) were stopped in high-purity A, Ne, and He at pressures ranging from 0.01 to 3.0 atm. Light from the stopping region was collected by a large solid-angle light pipe and directed to a photomultiplier. Spectra were obtained by inserting a series of optical interference filters in front of the photomultiplier. Identical spectra were obtained with an intense electron emitter replacing the ^{64}Cu source. These results indicate that any Lyman-α radiation present at the photomultiplier is masked by a large background continuum associated with gas excitation processes. The data were employed to set an upper limit of 1 in 2000 on positrons stopping in the gas with resultant Lyman-α radiation. (auth)

Collision Phenomena

Refer also to abstract 30597.

30154 (IPP-7/1) POLARIZATION EFFECTS IN ELASTIC ELECTRON SCATTERING. Eckstein, W. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Feb 1970. 125p. (In German). Dep. CFSTI (U. S. Sales Only).

A review is given of elastic electron scattering and the resulting spin polarization effects. The energies investigated range from 1 eV to about 1 MeV, and the range of scattering angles is above about 20°. In the theoretical part methods of calculating the differential cross sections and Sherman functions are described and numerical results given. The second part contains experimental results and compares them with theoretical values. In the third and last part polarization measurement by scattering is discussed in detail. (auth)

30155 (ORO-2591-47) FORMATION AND DESTRUCTION OF EXCITED HYDROGEN ATOMS AT HIGH IMPACT VELOCITIES. Edwards, J. L.; Thomas, E. W. (Georgia Inst. of Tech., Atlanta. School of Physics). 13 Jun 1970. Contract AT(40-1)-2591. 115p. Dep. CFSTI.

A study was made of the charge-transfer processes whereby fast, neutral atoms of hydrogen are formed in the 3s, 3p, and 3d excited states as a result of the impact of protons on targets of

helium and nitrogen. The procedure involved quantitative measurement of the Balmer alpha radiation emitted in spontaneous decay of the excited atoms. The fact that the 3s, 3p, and 3d states have substantially different lifetimes permitted the use of a time-of-flight technique to identify separately their contributions to the emission. Detailed measurements of the collisional formation and destruction processes are presented for targets of He and N_2 for impact energies from 75 to 400 keV. An assessment is also made of the effect on the measurements of other secondary processes. Comparisons are made with theoretical predictions and with other experimental measurements. The cross section for capture into the 3s state is by far the largest of the three capture cross sections and is larger for a nitrogen target than for helium. Cross sections for capture into the 3p and 3d states are one to two orders of magnitude smaller, but the fraction of the atoms formed in the p and d states is slightly larger in nitrogen than in helium. There is agreement with other measurements within experimental error. Calculations utilizing the Born approximation are available for a target of helium, and there is agreement with the predictions for capture into the 3s and 3d states. However, the calculation for the 3p state appears to overestimate the cross section by a factor of at least four. The cross sections for collisional destruction of atoms in the 3s state are several orders of magnitude larger than for electron capture into this state, and the magnitudes of the measured values are in agreement with theoretical predictions. A less-detailed report of this work is being prepared for publication. (auth)

30156 (SRIA-115-P-84-1) PROCESSES OF ENERGY DEPOSITION BY HEAVY PARTICLE IMPACT. Technical Report No. 1, June 23, 1969-March 23, 1970. Lorents, Donald C. (Stanford Research Inst., Menlo Park, Calif.). 25 Mar 1970. Contract AT(04-3)-115. 11p. Dep. CFSTI.

Preliminary results are reported for a study of K-shell excitation in collisions of Li^+ with He at primary energies up to 2000 eV. At 2000 eV energy-loss spectra of the scattered Li^+ ions show two prominent peaks, one at 22 eV and one at 62 eV. Plans for further measurements and for data analysis are discussed briefly. (A.G.W.)

30157 (UCRL-19712) ELECTRON IMPACT EXCITATION OF HEAVILY IONIZED ATOMS. Golshani, Mehdi (California Univ., Berkeley. Lawrence Radiation Lab.). 26 Feb 1970. Contract W-7405-eng-48. 41p. Dep. CFSTI.

Thesis.

The Coulomb–Born approximation is used to calculate the total cross section for the electronic excitation of ionized atoms. When the incident energy is high and the atom is highly ionized, the eikonal and classical approximations can be used simultaneously. In this case the scattering amplitude reduces to a one-dimensional path integral. The path integral, in turn, can be reduced, to any desired accuracy, to a sum over integrals that can be done analytically. This procedure was used to calculate the total cross sections for the heavily ionized atoms Fe^{15+}, Co^{16+}, Ni^{17+}, and Cu^{18+}. (auth)

30158 GAMMA-RAY ATTENUATION-COEFFICIENT MEASUREMENTS. Conner, A. L. (Los Alamos Scientific Lab., N. Mex.); Atwater, H. F.; Plassmann, Elizabeth H.; McCrary, J. H. Phys. Rev., A; 1: 539-44(Mar 1970).

Total γ-ray attenuation coefficients have been measured at nine energies in the range of 88 keV to 2.75 MeV for the following elements: Be, C, Mg, Al, S, Ti, Fe, Ni, Cu, Zn, Zr, Nb, Mo, Ag, Sn, La, Gd, Hf, W, Au, Pb, Th, U, and Pu. Radioactive isotopes were used as sources of monoenergetic γ radiation in a narrow-beam-collimated geometry. Experimental errors are less than 1%. (auth)

30159 FORMATION OF CHARGED AND EXCITED PARTICLES IN COLLISIONS BETWEEN NOBLE GAS IONS OR ATOMS AND HYDROGEN MOLECULES. Polyakova, G. N.; Gusev, V. A.; Erko, V. F.; Fogel, Ya. M.; Zats, A. V. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz.; 58: 1186-96(Apr 1970). (In Russian).

The effective cross sections for H_2^+ and H^+ production in collisions between 3- to 40-keV He, Ne and Ar ions or atoms and H_2 molecules were measured by the mass-spectrometer technique. The effective cross sections for the H_α and H_β excited lines of the Balmer hydrogen series and for some spectral lines of He, Ne, and Ar atoms and ions arising in collisions between 0.1 to 30 keV atoms and ions of the same noble gases and H_2 molecules are measured by the mass-spectroscopic technique. The results of the measurements show that many $\sigma(\nu)$ curves (σ is the effective cross section for a certain collision process and ν is the relative velocity of the colliding particles) exhibit peaks in the region of small impinging particle energies. The peaks cannot be explained on the basis of the Massey adiabatic condition. Possible causes of the peaks are discussed. (auth)

30160 NOTE ON THE METHODS OF DETERMINING THE SUBSHELL PHOTOELECTRIC CROSS SECTIONS. Parthasaradhi, K. (Andhra Univ., Waltair, India). Nucl. Instrum. Methods; 81: 205-6(1970).

The available methods for the determination of the subshell photoelectric cross sections of gamma rays are discussed. A few results on the subshell cross sections obtained by multiplying the total photoelectric cross sections by the subshell to total ratios are presented. It has been concluded that this method of obtaining the subshell photoelectric cross sections is not only simple but also better than a direct measurement in general. (auth)

30161 NONSYMMETRY OF THE CROSS SECTION FOR COLLISION-INDUCED EXCITATION OF HD^+ TO THE $2p\sigma_u$ STATE. Dong, Pham; Durup, Jean (Faculte des Sciences, Orsay, France). Chem. Phys. Lett.; 5: 340-2(1 May 1970).

The $1s\sigma_g \rightarrow 2p\sigma_u$ collisional excitation of fast HD^+ is unsymmetrical as regards forward or background ejection of a given fragment at zero scattering angle. The branching ratio $\sigma_{(D^+ + H)}/\sigma_{(H^+ + D)}$ is equal in both cases to 2.0 ± 0.1. (auth)

30162 DETERMINATION OF THE PARAMETERS OF THE LENNARD-JONES (12-6) POTENTIAL FOR Ar-Ar, Ar-CH_4, He-Ar, AND He-CH_4 BY MEANS OF SUPERSONIC MOLECULAR BEAMS. Eckelt, W. R.; Schimpke, B.; Schuegerl, K. (Technische Univ., Brunswick). Z. Phys. Chem. (Frankfurt); 68: 266-76(Dec 1969).

Supersonic molecular beams of helium and argon were produced by expanding the gas through a small nozzle and by the use of a conical skimmer and a collimator to form the beam. The intensity and velocity distribution of the beam particles were measured. Beams with high intensity and narrow velocity distribution were used to estimate the effective integral cross sections, as functions of the relative energy of the scattering partners, of helium and argon and methane using a scattering chamber. The functions of integral cross sections and/or effective integral cross sections versus relative energy of the scattering partners were calculated by means of the JWKB and high-energy approximations using the Lennard-Jones (12-6) potential. The parameters of this potential were estimated by fitting the calculated functions to the measured ones. (auth)

30163 MEASUREMENTS OF THE EFFECTIVE INTEGRAL CROSS SECTIONS OF POTASSIUM ATOMS ON ARGON ATOMS AND BROMINE MOLECULES BY MEANS OF DYNAMICAL POTASSIUM ATOMIC BEAMS AND A SCATTERING CHAMBER. Lassalle, H. J.; Schuegerl, K. (Technische Univ., Brunswick). Z. Phys. Chem. (Frankfurt); 68: 277-92(Dec 1969).

Dynamical potassium atomic beams, produced by means of a small nozzle and conical skimmer, are investigated. The velocity distributions of beam atoms are measured by a time-of-flight method. From the attenuation of the intensity of beams that pass through a scattering chamber, in which a given pressure of the scattering gas prevails, the effective integral cross sections Q_{eff} are evaluated. The Q_{eff}'s are calculated as functions of the relative energy of the scattering partners by integration of the Schrödinger equation using the Lennard-Jones (6-12) potential and different quantum mechanical approximations. The calculated functions are fitted to the measured ones, thus allowing the potential parameters of the Lennard-Jones potential to be estimated. (auth)

30164 INNER SHELL IONIZATION BY HEAVY, CHARGED PARTICLES AND ASSOCIATED ENERGY LOSS OF THE PROJECTILE. Hansteen, J. M. (Univ. of Bergen); Mosebekk, O. P. Z. Phys.; 234: 281-92(1970).

The process of L- and M-shell ionization of atoms by heavy, charged particles is analyzed in detail by a semiclassical, time-dependent perturbation method. The target electrons are described by nonrelativistic hydrogenic wave functions. For the projectile is assumed a well-defined straight-line path. The Coulomb deflection and the screening are partially taken into account. The theoretical values of the total cross section are in reasonable agreement with experimental values. The condition of validity for the semiclassical method is shown to be fulfilled for all nonrelativistic projectile energies. The projectile energy loss by ionization is further shown to be of negligible importance for the resolution of magnetic spectrographs used in nuclear structure physics. (auth)

Atomic Theory

30165 EFFECT OF CORRELATION ON THE NUCLEAR MAGNETIC SHIELDING CONSTANTS IN ATOMIC SYSTEMS.

Mazziotti, A. (Johns Hopkins Univ., Baltimore). Chem. Phys. Lett.: 5: 343-4(1 May 1970).

It is shown that accurate estimates of the true nuclear magnetic shielding constants in atoms can be obtained with considerable ease from approximate Hartree–Fock values. Extension of this estimation procedure to molecular systems is discussed. (auth)

30166 RUSSELL–SAUNDERS STATES ARISING FROM CONFIGURATIONS OF EQUIVALENT ELECTRONS. Wormer, P. E. S. (Duke Univ., Durham, N. C.). Chem. Phys. Lett.: 5: 355-6 (1 May 1970).

A short method is given for the classification of the atomic Russell–Saunders coupling terms arising from an $(l)^n$ configuration consisting of n equivalent electrons. The method uses Young diagrams. (auth)

30167 CORRELATION COEFFICIENTS FOR ELECTRONIC WAVEFUNCTIONS OF ATOMS IN S STATES AND LINEAR MOLECULES. Bingel, Werner A. (Univ., Goettingen, Ger.). Chem. Phys. Lett.: 5: 367-9(1 May 1970).

The connection between the correlation coefficients previously discussed by Kutzelnigg, del Re, and Berthier and the correlation factors introduced by McWeeny is determined. The correlation coefficients are then discussed for some special cases. It is shown that for atoms in S states the angular correlation coefficient τ is completely determined by the $l = 0$ and 1 contributions of the expansion of the pair density $\pi(r_1 \cdot r_2)$ the Legendre polynomials. For linear molecules the equatorial correlation coefficient τ_e can be expressed solely by the $\lambda = 0$ and 1 contributions of the Fourier expansion of $\pi(r_1 \cdot r_2)$ in terms of $\cos \lambda(\varphi_1 - \varphi_2)$. (auth)

Cosmic Radiation

Refer also to abstracts 29524, 29538, 29539, 30239, 30426, 30435, and 30445.

30168 (AD–699576) STUDY OF THE ABSOLUTE FLUX AND ENERGY SPECTRUM OF COSMIC RAY NEUTRONS IN THE ATMOSPHERE. Final Report, May 1, 1964–April 30, 1968. Ballerini, R.; Bland, J. C.; Boella, G.; Antoni, G. Degli; Dilworth, C. (Milan Univ. (Italy). Istituto di Scienze Fisiche). 1 Jul 1968. Contract AF61(052)-808. 39p. (AFCRL-69-189). CFSTI.

A neutron detector was constructed to measure the flux and energy spectrum of cosmic-ray neutrons in the atmosphere over the energy range (thermal energy, 20 MeV). The latitude effect of the neutron flux was determined by comparing the counting rate of the detector during balloon launches at different geomagnetic latitudes. A counting-rate variation with altitude was also observed due to a variation of the neutron energy spectrum with altitude. An improved version of the detector was made. The results of balloon and rocket launches led to a determination of the neutron flux as a function of the atmospheric depth, from 300 to 0.1 gm/cm sq cm. Furthermore, a high-energy neutron detector was made to measure the steady-state solar neutron flux over the energy range 30 to 120 MeV. Background estimation shows that a neutron flux from the Sun of the order of 0.001/cm^2/sec can be detected. (auth) (USGRDR)

30169 (AECL-3454(Rev.)) COSMIC RAY NM-64 NEUTRON MONITOR DATA. XIII. Monthly Graphs, May–August 1969. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Sep 1969; Revised Mar 1970. 66p. Dep. CFSTI (U. S. Sales Only). AECL $1.50.

Uncorrected and barometer-corrected results from the cosmic-ray stations in Canada, using equipment maintained by AECL, are given in tabular form for the period from May to August, 1969. Normalized graphs are given for the same period. (auth)

30170 (AECL-3560) COSMIC RAY NM-64 NEUTRON MONITOR DATA. XIV. Monthly Graphs, September–December 1969, Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb 1970. 66p. Dep. CFSTI (U. S. Sales Only). AECL $1.50.

Uncorrected and barometer-corrected results from the cosmic-ray stations in Canada, using equipment maintained by AECL, are given in tabular form for the period from September to December, 1969. Normalized graphs are given for the same period. Correction factors for the constant rates of drift of the barometers at Alert and Goose Bay were determined and are now given. (auth)

30171 (CEA-R-3979) STUDY OF THE X RADIATION BETWEEN 10 AND 100 keV PRODUCED IN AND ABOVE THE ATMOSPHERE. Rothenflug, Robert (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1970. 117p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Orsay, France.

To measure the x radiation within this energy range a detector consisting of a NaI(Tl) scintillator combined with a photomultiplier, of surface area 7 cm^2 and of yield close to 1, between 10 and 100 keV was used. The detection unit was carried by stratospheric balloons up to altitudes of about 40 km where the atmosphere was sufficiently transparent to allow observation of radiations coming from outside the atmosphere. The atmosphere is the center of ionizing radiations that give rise to parasitic x rays in air and in the materials surrounding the detector. The different components of these parasitic radiations were studied. Then measurements of the diffuse x radiation of extraterrestrial origin in three different directions showed that it is isotropic within the limits of experimental accuracy (20%). The diffuse x-ray spectrum takes the form: $DN/DE = (2.1 \pm 0.4) \times 10^{12}\ E^{-2.43 \pm 0.05}$ ph/$cm^2 \cdot s \cdot ster \cdot keV$, for E expressed in keV, between 14 and 90 keV. The possible origins of the diffuse radiations are discussed. (France)

30172 (N-70-16721) COSMIC RAYS AND THE TERRESTRIAL ATMOSPHERE. Miroshnichenko, L. I. Translated from Priroda; No. 5, 18-29(1969). 20p. (NASA-TT-F-12785). CFSTI.

A general description of the effects of cosmic rays on the terrestrial atmosphere and vice versa is presented. The relationship of cosmic radiation to latitude is examined, with the intensity of the former found to increase toward the poles. The barometric effect, the influence of atmospheric temperature, interference with shortwave radio communication, and the relationship of cosmic weather to terrestrial weather conditions are discussed. A detailed description of the causes and effects of cascade showers is presented. (auth) (STAR)

30173 (N-70-20441) COSMIC RAY NEGATRON AND POSITRON SPECTRA OBSERVED NEAR FORT CHURCHILL IN 1968. Beuermann, K. P.; Rice, C. J.; Stone, E. C.; Vogt, R. E. (California Inst. of Tech., Pasadena). Aug 1969. 20p. (NASA-CR-108937; SRL-69-7). CFSTI.

The differential energy spectra of cosmic-ray positrons and negatrons between 12 and 210 MeV were measured with a balloon-borne magnetic spectrometer launched from Fort Churchill, Canada, in summer 1968. Since the geomagnetic cutoff varies with time, separate spectra for the local day and night intervals are presented. In addition, the corrections for atmospheric secondary electrons are discussed in detail. The solar modulation of the positron flux is compared with the modulation of cosmic ray nuclei. (auth) (STAR)

30174 (N-70-21655) STATISTICAL DISCRETE-SOURCE MODEL OF THE LOCAL COSMIC RAYS. Ramaty, R.; Reames, D. V.; Lingenfelter, R. E. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar 1970. 11p. (NASA-TM-X-63847; X-661-70-80). CFSTI.

Implications of a revised limit on the sidereal anisotropy of cosmic rays were investigated. Calculations of the fluxes, interactions, lifetimes, and anisotropies of chemical components of cosmic rays are presented in a statistical discrete-source model. Within this model, the discrepancy between isotropy and cosmic-ray lifetimes is resolved by assuming that streaming velocity is low and lifetimes are determined by nuclear interactions and not by escape. When the combined effects of the statistical model and a low streaming velocity are considered, several of the measurable properties of the cosmic rays, particularly the abundances of nuclei heavier than iron, exhibit large fluctuations that must be taken into account in order to interpret the observational data. It is assumed that the cosmic-ray sources are supernova explosions confined to a disk of thickness 200 pc with a random spatial and temporal distribution. (STAR)

30175 (N-70-23200) LOW-RIGIDITY COSMIC RAYS IN THE INTERSTELLAR MEDIUM. Balasubrahmanyan, V. K.; Boldt, E. A. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar 1970. 9p. (NASA-TM-X-63862; X-661-70-94). CFSTI.

Measurements of the galactic radio background at approximately 1 MHz imply that the intensity of low-rigidity (approximately 0.3 GV) electrons beyond the solar system is much greater than that directly observed near the Earth. Taking this depression of intensity as arising mainly from a solar modulation applicable to all cosmic rays of comparable rigidity, it is shown that the flux of subrelativistic protons and alpha particles in the galaxy would be sufficient for heating the interstellar H I gas and providing the ionization needed for maintaining the large electron content indicated by pulsar dispersion measures. A nonuniform spatial distribution of galactic cosmic rays would be a consistent feature of this description. (auth) (STAR)

30176 A POSSIBLE MECHANISM FOR THE METEOR-CORRELATED VARIATION IN THE COSMIC-RAY INTENSITY. Bel'skii, S. A. (Ioffe Inst. of Physics and Tech., Moscow). Sov. Astron. AJ (Engl. Transl.); 13: 1044-6(May-Jun 1970).

Translated from Astron. Zh.; 46: 1330-2(Nov-Dec 1969).

A possible mechanism is discussed for the effect reported previously (Bel'skii (1968)) in which the cosmic-ray intensity increases during periods of maximum meteor-stream activity. The effect is ascribed to the presence of regular magnetic fields in meteor streams, acting as cosmic-ray traps. The magnetic field formed in a meteor stream because of the motion of charged micrometeoroids through the interplanetary plasma is estimated to have an intensity of $\approx 10^{-5}$ gauss, which is of the same order as the magnetic fields observed in interplanetary space. Meteors are especially likely to acquire a charge during years of maximum solar activity, when the flux of ionizing x rays and ultraviolet radiation is greatly increased; this circumstance would evidently explain the absence of a meteor-correlated increase in the cosmic-ray intensity during years of minimum solar activity and the presence of such an effect during years of solar minimum. (auth)

30177 SHORT-TERM INTENSITY VARIATIONS OF COSMIC RADIATION. Dubinsky, J.; Chaloupka, P. (Inst. of Experimental Physics, Kosice, Czech.). Czech. J. Phys.; 20: 453-63(1970).

The problem of variations shorter than an hour was studied by means of the dispersion as a function of the length of the registration interval. The type of aforementioned dependence leads to the conclusion that even in the time of low solar activity the existence of such variations can be proved. (auth)

30178 CHEMICAL COMPOSITION OF RELATIVISTIC COSMIC RAYS DETECTED ABOVE THE ATMOSPHERE. Durgaprasad, N. (Goddard Space Flight Center, Greenbelt, Md.); Fichtel, C. E.; Guss, D. E.; Reames, D. V.; O'Dell, F. W.; Shapiro, M. M.; Silberberg, R.; Stiller, B.; Tsao, C. H. Phys. Rev., D; 1: 1021-8(15 Feb 1970).

Final results on the first satellite experiment on abundances of cosmic-ray nuclei having a mean energy of several GeV per nucleon are presented. A nuclear-emulsion detector, exposed on Gemini XI in a near-equatorial orbit ranging between geographic latitudes ±29°, collected 619 high-quality tracks above the earth's atmosphere. Time resolution (within about 5 min) was provided by movement of a lower emulsion stack relative to an upper one. The detector was covered by only 0.07 g/cm^2 of aluminum and was favorably oriented for 18 h. The results on abundances, requiring no correction for secondary production in the atmosphere, are characterized by (a) a pronounced odd-even effect, with low abundances for elements of atomic number 7, 9, 11, and 13, compared to those of neighboring elements with even Z; (b) approximately equal fluxes of neon, magnesium, and silicon, each being about one-fourth that of oxygen; and (c) an abundance gap in the region $15 \leq Z \leq 19$. The observed ratios of Be + B, $10 \leq Z \leq 19$, and $Z \geq 20$ to the medium group, $6 \leq Z \leq 9$, provide no evidence for significant variation of composition with rigidity between 3.5 and 30 GV. A primordial composition—prior to interactions of the cosmic rays with the interstellar medium—is calculated. This source composition is compared with "universal" and solar abundances. (auth)

30179 ESTIMATE OF THE PROMPT PHOTON SPECTRUM ARISING FROM COSMIC RAY BOMBARDMENT OF THE MOON. Armstrong, T. W.; Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). Astronaut. Acta; 14: 143-9(1969).

An estimate has been made of the photon leakage spectrum from the Moon due to photons arising from the capture and inelastic scattering of neutrons produced by galactic cosmic rays. The method of calculation consisted of estimating the energy and spatial distribution of the neutron flux in the Moon and then using Monte Carlo methods to obtain the photon source and to perform the photon transport. While the photon production and transport are carried out with some exactitude, the results must be considered very approximate because of the approximate neutron flux distribution that is used. In particular, no attempt is made to account for the important effect which hydrogen in the lunar composition would have on the neutron flux distribution. (Excerpta Med.)

30180 COHERENT AND INCOHERENT RADIO EMISSION FROM EAS. Mandolesi, N.; Palumbo, G. G. C. (Univ., Bologna). Lett. Nuovo Cim.; 3: 40-2(8 Jan 1970).

In an experiment performed at the "Northern Cross" Italian Radio Telescope, radio pulses from extensive air showers (EAS) were simultaneously detected at 30 MHz and 408 MHz. One aim was to investigate the presence of radio emission from the shower disc in the uhf region as well as to confirm the emission at lower frequencies. An explanation of the data obtained is attempted. A few results are added, a more detailed analysis having been done for both frequency channels on 500 traces, corresponding to triggering EAS of most probable energy $\sim 5 \times 10^{15}$ eV. (M.H.R.)

30181 11-YEAR MODULATION OF COSMIC-RAY INTENSITY AND THE HELIOLATITUDINAL DISTRIBUTION OF SPOTS. Stozhkov, Yu. I.; Charakhch'yan, T. N. (Lebedev Inst. of Physics, Moscow. Moscow State Univ.). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 649-52(1969).

Translated from Geomagn. Aeron.; 9: 803-7(1969).

From an analysis of 11-year cosmic-ray variations and of the 11-year solar activity cycle it follows that the amplitude of variation depends not only on the number of spots, but also on their average solar latitude. Allowance for this relationship permits explanation of the hysteresis phenomenon in cosmic rays. It is concluded that the properties of corpuscular streams, responsible for cosmic-ray modulation, vary with the solar latitude of the spots. (auth)

30182 DEPENDENCE OF THE INCREASE BEFORE FORBUSH DECREASES ON THE ENERGY SPECTRUM OF COSMIC RAYS. Dorman, L. I.; Kaminer, N. S.; Kebuladze, T. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Inst. of Geophysics, Tbilisi, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 653-5(1969).

Translated from Geomagn. Aeron.; 9: 808-12(1969).

The dependence on the cosmic-ray spectrum of the amplitude of the increase in cosmic rays before Forbush decreases is examined. It is shown that there is no such relationship within the limits of experimental errors. (auth)

30183 INFLUENCE OF FORBUSH EFFECTS ON THE STATE OF THE COSMIC LAYER IN THE LOWER IONOSPHERE. Velinov, P.; Dorman, L. I.; Nestorov, G. (Geophysical Inst., Sofia. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 656-9(1969).

Translated from Geomagn. Aeron.; 9: 813-17(1969).

The behavior during Forbush effects of the cosmic layer at a height of 50 to 80 km in the lower ionosphere is examined. A quantitative explanation of experimental data is given on the basis of an analysis of the rate of electron production in the cosmic layer during Forbush effects. (auth)

Direct Energy Conversion

Refer also to abstract 29936.

30184 (N-70-18760) A DESIGN STUDY FOR A MAGNETOHYDRODYNAMIC POWER SYSTEM FOR A NUCLEAR ELECTRIC PROPELLED UNMANNED SPACECRAFT. Midterm Report, May 26–December 25, 1969. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Contracts NAS7-100; JPL-952415. 102p. (NASA-CR-108085; GESP-7025). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

The progress made in the first half of a one-year design study of nuclear-electric propelled unmanned spacecraft using a magnetohydrodynamic (MHD) power system is discussed. The study guidelines and approach are defined here, and the characteristics of one launch vehicle, the thruster subsystem, and the payload and communications system are presented. The MHD power conversion system is described and methods used to calculate MHD system parameters are discussed. A discussion of the arrangement and structural arguments used to select system configuration is included. The system startup technique is identified, and the detailed design and weight summary of the baseline 300-kWe system are presented. (auth) (STAR)

30185 (NP-18242) ANNUAL REPORT OF ENERGY CONVERSION RESEARCH GROUP. (Sydney Univ. (Australia). School of Electrical Engineering). May 1969. 40p. Dep. CFSTI (U. S. Sales Only).

Progress in the areas of energy conversion studies, induction plasma and shock wave studies, and arc studies and synthetic testing, is discussed. Particular emphasis is placed on magnetohydrodynamics. Staff and publications are listed for 1968-69. (Australia)

30186 (TID-25414) FUSION POWER: DIRECT CONVERSION AND THE REDUCTION OF WASTE HEAT. Post, R. F. (California Univ., Livermore. Lawrence Radiation Lab.). [nd]. 16p. Dep. CFSTI.

Fusion reactors are discussed in the context of the direct conversion of fusion energy to electricity. The use of particles released from fusion reactors for the purpose of direct conversion is discussed. The use of different fuels and different conversion cycles is also discussed. (M.O.W.)

30187 MHD GENERATOR CHARACTERISTICS WITH INSULATOR WALL LOSSES. Decher, Reiner (Univ. of Washington, Seattle). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 132-7(Jan 1970).

An analysis is presented that delineates the important electrical effects of boundary layers on the insulator wall of a magnetohydrodynamic generator. For specified variation of the fluid properties associated with the boundary layer, the electrical characteristics may be used to identify shorting through the insulator-wall boundary layer in an experimental investigation. Two numerical examples considering seeded-gas MHD generators with equilibrium and nonequilibrium ionization show that, if the channel dimension in the magnetic field direction is 10 to 100 times larger than the boundary-layer thickness, insulator wall shorting should have a negligible effect on the generator's performance. The equations are also generalized to investigate the effects of an insulator wall with finite scalar resistivity. (auth)

30188 INSTABILITY OF HALL MHD GENERATORS TO MAGNETO-ACOUSTIC WAVES. Fishman, Frank J. (Avco Everett Research Lab., Everett, Mass.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 632-9(Apr 1970).

It is known that magneto-acoustic wave propagating antiparallel to a steady electric current in a dense, weakly ionized gas may exhibit substantial growth. The stability of a Hall MHD generator with supersonic flow to disturbances of this type is assessed. A proper boundary-value problem for an unsteady, one-dimensional model of such a generator is solved, with full consideration of the load circuit, which may serve as a feedback path for wave energy. It is shown that this feedback may lead to instabilities even under conditions such that the wave growth (as evaluated by earlier investigations) is slow. Disturbances with a period comparable to the flow time (channel length/fluid velocity) are the principal contributors to the instability; the spatial variation of these disturbances are far from sinusoidal. The control of machine instabilities by electrical filters in the external (load) circuit is described. (auth)

Fluid Physics

30189 (AD-685748) ON AN ELECTRIC-CURRENT-CARRYING DISCONTINUITY DRIVEN THROUGH NONCONDUCTING GAS BY A LORENTZ FORCE. Gallington, Roger W. (Frank J. Seiler Research Lab., USAF Academy, Colo.). Dec 1968. 190p. (SRL-68-8). CFSTI.

A physical model is presented for an electric current-carrying discontinuity separating two uniform states in a flowing gas. The physical model is composed of a thin shock wave followed closely by a thicker current sheet in which the viscosity and thermal conductivity are zero. The electrons and ions move only in the plane of the current sheet (in discontinuity fixed coordinates) and have no component of velocity in the streamwise direction. The momentum and energy exchange terms occurring in the species momentum and energy equations reduce to a particularly simple form based on a slightly ionized gas and a constant-collision-frequency model. Coulomb attraction causes the electron charge density to equal the ion charge density. A three-fluid analysis (electrons, neutrals, and singly ionized ions) of this model is made for the case where the component of the magnetic field normal to the plane of the discontinuity is zero. The analysis results in a system of equations involving two ordinary differential equations. The values of all the dependent variables in the current sheet are computed from these equations as a function of distance in the streamwise direction. It is found that this model will admit as solutions finite-strength current sheets. (auth) (USGRDR)

30190 (AD-700927) INVESTIGATIONS ON THE FORMATION AND PROPAGATION OF THE PLASMA IN MHD CHANNEL FLOWS. Annual Technical Report No. 1, January 1-December 31, 1969. Wilhelm, Horst E. (Colorado State Univ., Fort Collins. Dept. of Mechanical Engineering). 26 Jan 1970. Contract N00014-67-A-0299-0008. 135p. CFSTI.

Specific investigations relevant to technical plasmas are reported, in particular plasmas in energy conversion systems. A kinetic theory of subsonic and supersonic transport processes is given for weakly ionized and fully ionized plasmas. Subsonic and supersonic transport processes are discussed by means of typical examples (current transport in strong electric fields, thermal nonequilibrium in strong electric fields, and the test-particle problem). Analytical solutions are established for the boundary-value problem of the convection and diffusion of temperature and particle distributions in gaseous flows, and for the nonlinear Helmholtz equation describing the ionization-recombination kinetics with diffusion. A perturbation theoretical solution is derived for the nonlinear space-charge problem of a plane plasma capacitor in a strong electric field, and an analytical model is developed for the nonlinear space-charge oscillations excited by application of a strong voltage pulse. A preliminary account on the problem of ionization of excited atoms by turbulent electric fields in plasmas and the magnetohydrodynamic turbulence in presence of a strong magnetic field is presented. (auth) (USGRDR)

30191 (AD-701386) INTERNAL MHD CHANNEL FLOWS INCLUDING HALL EFFECT AND VARIABLE FLUID PROPERTIES. Final Report. Snyder, William T.; Maus, James R. (Arnold Engineering Development Center, Arnold Air Force Station, Tenn. ARO, Inc., Arnold Air Force Station, Tenn. Tennessee Univ., Tullahoma. Space Inst.). Feb 1970. Contract F40600-67-C-0001. 89p. (AEDC-TR-70-26). CFSTI.

An analysis is presented of MHD channel flow with Hall effect and variable fluid properties. Because of the highly nonlinear nature of the governing conservation equations, a straight numerical analysis of the equations is followed, based on the implicit finite-difference method. The analysis considers the two-dimensional flow in the electric field plane in which the channel walls are electrode surfaces. Because of the presence of the Hall effect, a transverse pressure gradient is induced in the flow that necessitates the use of two equations of motion in the longitudinal and transverse directions. The analysis model employed is the so-called slender channel model in which the boundary layer forms of the equations of motion are applied across the entire channel width. Because the boundary layer equations are parabolic, it is possible to integrate the equations in a forward-marching manner by starting with initially prescribed velocity and enthalpy profiles at the channel entrance. (auth) (USGRDR)

30192 (NP-18101) FLOWS WITH QUASI-ALIGNED FIELD IN MAGNETODYNAMICS OF FLUIDS. Thibault, Roger (Paris Univ. (France). Faculte des Sciences). 1965. 94p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

The present study of fluid magnetohydrodynamics is undertaken in the hypothesis of a continuous distribution of matter and that the relations that bind the mechanical magnitudes (speed, density, pressure, internal energy) can be formed directly by integral equations. From these, when the unknown functions are continuously differentiable, the equations with partial derivatives define the continuous movement, or when these functions are discontinuous, the algebraic relations define the collision phenomena. For a stationary two-dimensional movement of a compressible fluid, but nondissipative, it is shown that the methods applicable to plane movements with aligned fields can be used for the study of the projection of the flow on the reference plane. (TSS)

30193 PRODUCTION OF HIGH-CURRENT-DENSITY ION BEAMS BY ELECTROHYDRODYNAMIC SPRAYING TECHNIQUES. Swatik, Donald Stephen. Urbana, Ill.; Univ. of Illinois (1969). 100p.

Thesis.

The production of high-current-density ion beams by the direct interaction of an intense electric field on a liquid surface was investigated. Electrohydrodynamic spraying techniques, which have been traditionally utilized for the production of multimolecular charged-particle beams, were optimized for the production of ionic particles. Simultaneous ion formation and acceleration was achieved by applying a high dc voltage between a hemispherical liquid meniscus supported at the tip of a metallic capillary and a concentric, planer accelerating electrode. With proper feedback control of the applied voltage and proper wetting of the capillary by the working fluid, the hemispherical meniscus could be deformed by the action of the applied electric field into a stable conical geometry. At the apex of this cone the electric field intensity was of sufficient amplitude to field-evaporate ions from the liquid surface. Such a field evaporation source using a liquid anode can operate indefinitely at high emitted current levels. The field-evaporated particles were analyzed to determine the usefulness of this technique as a source of charged particles for electric thrusters. The total emitted current, specific charge distribution of the emitted particles, and formation energy of the particles were measured in terms of the operating parameters of the system. Stable ion currents of up to 500 μA were obtained by spraying the eutectic alloy of gallium and indium from a single capillary emitter. The ion beam consisted of 75% gallium dimers, 24% indium dimers and 1% gallium tetramers. The maximum thrust produced was 73.8 micronewtons, and the ion formation energy was less than 100 eV at all current levels. The low formation energy of the field emitted ions led to a high particle-formation efficiency at low accelerating voltages (i.e., low exhaust velocities) and the narrow specific charge distribution produced a beam conversion efficiency of 97.5%. The two desirable conditions of high particle-formation efficiency and high beam-conversion efficiency, along with the usable thrust output obtained, make this technique an ef-

ficient applicable means of converting electrical energy into thrust. (Diss. Abstr. Int., B)

30194 SOME SLOW MAGNETOHYDRODYNAMIC MOTIONS OF AN ELECTRICALLY CONDUCTING FLUID CONTAINED IN A SPHERICAL CASING. Vacca, Jacopa (Univ., Turin). Atti Seminar. Mat. Fis. Univ. Modena; 18: 282-94(1969). (In Italian).

The slow magnetohydrodynamic motion of an electrically conducting fluid contained in a spherical casing, exposed to a uniform magnetic field and to nonelectromagnetic forces deriving from a potential, was studied. In order to determine the velocity, the Clebsch theorem was applied; by considering only periodic motions with respect to time and solutions with axial symmetry, it was necessary to resolve a Neumann problem. A particular case of expressing the unknowns by means of Legendre polynomial series was studied in which some Bessel functions of the first species were used. (tr-auth)

30195 MAGNETOHYDRODYNAMIC BOUNDARY-LAYER FLOW WITH SUCTION OR INJECTION PAST A SEMI-INFINITE FLAT PLATE. Katagiri, Masakazu (Yamagata Univ., Yonezawa, Japan). J. Phys. Soc. Jap.; 28: 1570-5(Jun 1970).

The steady two-dimensional magnetohydrodynamic boundary-layer flow with a uniform suction or injection past a semi-infinite flat plate in the cross fields is studied on the assumption of small magnetic Reynolds number. The transformed boundary layer equation is found to be a nonsimilar one and an attempt is made to solve it numerically by a difference–differential method originated by Hartree and Womersley. Numerical results for various values of parameters are given for the velocity profile, coefficient of skin friction, displacement thickness, and momentum thickness, and the effects of the magnetic field on a role of suction or injection are investigated. (auth)

30196 MULTIDIMENSIONAL LAGRANGE PROBLEMS OF OPTIMIZATION IN A FIXED DOMAIN AND AN APPLICATION TO A PROBLEM OF MAGNETOHYDRODYNAMICS. Cesari, L. Arch. Ration. Mech. Anal.; 29: No. 2, 81-104(1968).

The applications of some existence theorems for solutions in Sobolev spaces of multidimensional Lagrange problems of optimization to the case where the partial differential equations are written in canonical form are studied. The existence theorems are applied to optimum problems for elliptic differential equations arising in magnetohydrodynamical channel flow. (Appl. Mech. Rev.)

Geophysics (Upper Atmosphere)

Refer also to abstracts 30098 and 30183.

30197 (AD–688514) FARADAY ROTATION SYSTEM FOR MEASURING ELECTRON DENSITIES. Rubio, Roberto (Army Electronics Command, White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.). Mar 1969. 31p. (ECOM–5243). CFSTI.

The Faraday-rotation radio propagation experiment for measuring electron densities in the 60- to 90-km region of the ionosphere is described. After a brief introduction of the Faraday rotation theory, its applicability at 32° N latitude (WSMR) is explained. The experimental procedure that is followed, the ground transmitting equipment, rocket payload, and receiving instrumentation are also described. (auth) (USGRDR)

30198 (AD–691866) COMPARATIVE STUDY OF IONOSPHERIC MEASUREMENT TECHNIQUES. Booker, Henry G.; Smith, Ernest K. (RAND Corp., Santa Monica, Calif. California Univ., San Diego. Dept. of Applied Physics and Information Science. Environmental Science Services Administration, Boulder, Colo. Research Labs.). Aug 1969. 73p. (P–4168). CFSTI.

Different methods of measuring ionospheric profiles of electron density, electron temperature, and ion temperature are compared. The methods listed for the upper ionosphere and for the lower ionosphere. Only comparisons involving nearly simultaneous observations near the same locations are included. Below 100 km, the radio rocket method appears to have the greatest accuracy. Nevertheless, the ground-based partial reflection and wave-interaction methods need to be developed for continuous observation of electron-density profiles. Above 100 km, satellite methods, particularly the topside ionosonde, are important for obtaining global coverage. But for accuracy of measurement of electron density, electron temperature, ion temperature (and several other aeronomically vital parameters), ground-based methods, particularly the incoherent backscatter radar, are superior in the altitude range 100 to 1000 km. (auth) (USGRDR)

30199 (AD–697055) STUDIES OF THE IONOSPHERE AT GEOMAGNETICALLY CONJUGATE STATIONS. Final Technical Report, August 1, 1966–August 31, 1969. Yeh, Kung C.; Flaherty, Bernard J.; Cho, Han R. (Illinois Univ., Urbana. Ionosphere Radio Lab.). Sep 1969. Contract F19628-67-C-0028. 130p. (TR–37; AFCRL–69-419). CFSTI.

The report consists of three parts. The first part describes a polarimeter system that was developed and used to measure polarization of signals from geostationary satellites. Circuit diagrams and sample data are given. The system is a modification of a system described by Titheridge. The second part describes the Cold Bay operation. Electron content data were scaled and processed for the period December 25, 1968, through April 30, 1969. When compared with Urbana, Cold Bay shows very flat content curves at winter night, very few pre-sunrise dips and wave trains in electron content with periods varying from three to five minutes in addition to normal traveling disturbances. The day-to-day change in electron content is found to be anti-correlated at geomagnetically conjugate stations during magnetic quiet days and to be correlated during magnetic disturbances. The third part describes some theoretical work. Several other effects such as the magnetic declination effect and the effect of a dynamo electric field were studied. (auth) (USGRDR)

30200 (AD–697105) GLOBAL ELECTRICAL CURRENTS. Webb, Willis L. (Army Electronics Command, White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.). Oct 1969. 40p. (ECOM–5271). CFSTI.

The atmospheric electrical structure of the Earth is postulated to be controlled by a motivating force in the lower ionosphere that is produced by interaction between neutral atmosphere tidal circulations and the ionospheric plasma in the presence of the Earth's magnetic field. Associated electric fields power the dynamo currents through the Hall effect with a resulting development of a gross electric potential distribution in the lower ionosphere. Asymmetries in these hemispheric potential distributions result in exospheric current flows in low L shells, and larger differences in potential produced by dynamo return current flows in high magnetic latitudes result in strong currents through high L shells between auroral zones. Vertical thunderstorm currents with their associated lightning discharges effectively connect the earth to a low-potential region of the dynamo circuit and thus supply the Earth with an average negative charge that motivates a leakage tropospheric electrical circuit. (auth) (USGRDR)

30201 (AD–702467) ORIGIN OF AURORAL PRIMARIES. Final Scientific Report, August 1, 1966–September 30, 1969. Dungey, James W. (Imperial Coll. of Science and Technology, London (England). Dept. of Physics). 30 Sep 1969. Contract AF61(052)-927. 17p. (AFCRL–70-19). CFSTI.

The theory of the neutral sheet in the geomagnetic tail has reached the point where noise should be taken into account. The problem of the sheet is formidable, but is tractable assuming it can be treated as a boundary layer. There is no fundamental need for noise to occur, but the distribution function derived from previous work suggests that noise would be generated. Because the sheet is so thin, radiation out from the sides might quench the instability. It was shown that this radiation can be calculated in a straightforward way and some computations were published. A method was also developed for calculating the energy fed into waves from particles. An approximate method of evaluation, valid for all but the longest wavelengths, yields reasonably simple formulas, and the application of this method to electrostatic waves is described. Once a self-consistent model of the noise-free sheet has been set up, these methods are sufficient to determine the nature of any noise generated. (auth) (USGRDR)

30202 (N–70-16961) TRAPPED PROTONS ≥100 keV AND POSSIBLE SOURCES. Williams, D. J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan 1970. 30p. (NASA-TM-X–63797; X–640-70-9). CFSTI.

The general characteristics of the trapped ≥100-keV population, the principal time variations observed, and the status of major source and transport mechanisms, with primary emphasis on diffusion by violation of the third adiabatic invariant are considered. (auth) (STAR)

30203 (N–70-18676) A PHOTOELECTRIC STUDY OF THE NIGHTGLOW. Final Report, June 1, 1964–October 31, 1968. Weinberg, J. L. (Hawaii Univ., Honolulu). Nov 1968. 98p. (NASA-CR–108086). CFSTI.

A modified airglow telescope and a synchronous detection system were used to measure Stokes parameters of nightglow, and from this to determine zodiacal light characteristics. The one-color photometric system utilized a coupled rotating polaroid synchronous detector to measure, with Fabry optics, the brightness of the total and of the polarized component of the nightglow, and the orientation of the plane of polarization. Facility design and instrumentation, special-purpose and monitoring programs, observing

conditions, data reduction and calibration, and results of observing and interpretive programs are described. (STAR)

30204 (N-70-20444) PRODUCTION AND LOSS OF O(1D) IN THE NIGHTTIME F REGION. Forbes, Jeffry M. (Illinois Univ., Urbana. Aeronomy Lab.). 1 Jan 1970. 112p. (NASA-CR-108932). CFSTI.

The production and loss of atomic oxygen in the 1D state, O(1D), in the nighttime F region is studied. Quenching of O(1D) is studied in detail, and is concluded to be an important mechanism in the O I(6300Å) night airglow. In addition, the dissociative recombination of O_2^+ is found to yield 0.12 ± 0.06 O(1D) atoms per recombination. This result is accomplished by comparing theoretical calculations of the O I(6300Å) night airglow vertical volume emission rate with ground-based photometer observations of O I(6300Å). The experimental program is also described, and methods of data analysis are presented. (auth)(STAR)

30205 (N-70-20652) MAGNETOSPHERIC SUBSTORM EFFECTS ON ENERGETIC ELECTRONS IN THE OUTER VAN ALLEN BELT (SUMMARY OF TECHNICAL REPORT CR-137). Lezniak, T. W.; Winckler, J. R. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Apr 1969. 11p. (NASA-CR-108993; CR-137). CFSTI.

Empirical evidence is discussed for a substorm-associated acceleration process to account for the large electron increases seen in the post-midnight sector of the outer radiation belt at synchronous orbit by ATS-1. The increases shown have recurrent fluctuations in intensity in the three given channels, the largest fluctuations occur just after local midnight and decrease in intensity as local time increases, and the largest transient increases are observed for the 50 to 150-keV electrons. The total geomagnetic field strength at the spacecraft and the angle between the geomagnetic and the north-pointing vector are shown. (auth) (STAR)

30206 (N-70-21477) POLAR PEAK OF ELECTRON CONCENTRATION AT 1000 KILOMETERS ALTITUDE. Brace, L. H.; Mayr, H. G.; Mahajan, K. K. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan 1970. 29p. (NASA-TM-X-63836; X-621-70-14). CFSTI.

Satellite probe measurements from a circular, polar orbit at 1000 km altitude revealed a broad enhancement of ionization within the polar cap. The latitude of the maximum concentration closely follows the seasonal movement of the solar terminator across the polar cap. The peak is bounded on its nightside by a solar zenith angle of about 110° and on its dayside by a broad midlatitude trough near 60° geomagnetic latitude. Thus, one boundary of the peak, and the location of the maximum, is strongly influenced by solar zenith angle while the other boundary is geomagnetically fixed. Although the ionization and heating observed in the peak clearly arises from solar radiation, the most intriguing question is why a peak should be formed at all since this cannot be produced by zenith-angle variations alone. The answer appears to lie in the mechanisms that produce the midlatitude trough on the dayside. To explain the trough, the effects of neutral atmospheric winds flowing poleward on the dayside of the Earth in response to solar heating are studied. The observations are shown to agree quantitatively with solutions of the energy and particle equations of the plasma when a neutral wind field derived from a Jacchia model atmosphere is introduced and suitable allowance is made for an upward proton flux at high latitudes. (auth) (STAR)

30207 (N-70-21490) TWO-DIMENSIONAL GUIDING-CENTER MODEL OF THE SOLAR WIND-MOON INTERACTION. Whang, Y. C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb 1970. 36p. (NASA-TM-X-63845; X-692-70-61). CFSTI.

The characteristic theory and the computational method are discussed. The magnetic permeability of plasma is 1/(1 + Beta/2) in the solar wind flow upstream of the moon, and it changes to 1 in the void region of the lunar wake. The gradual change of the magnetic permeability in the penumbral region from the interplanetary condition to the void condition is explained as the source of field perturbations in the lunar wake. Perturbations of the magnetic field propagate as magneto-acoustic waves in a frame of reference moving with the plasma flow. Computer solutions were obtained to show that (1) the two principal perturbations of the magnetic field in the lunar wake (the umbral increase and the penumbral decrease) are confined to a region bounded by a Mach cone tangent to the lunar body, and (2) the penumbral increases occur outside the lunar Mach cone. Computer solutions are also used to identify the source of field perturbations and to simulate the solar wind-moon interaction under varying interplanetary conditions. (auth) (STAR)

30208 DETERMINATION OF THE COLUMNAR ELECTRON CONTENT AND THE LAYER SHAPE FACTOR OF THE PLASMASPHERE UP TO THE PLASMAPAUSE. Almeida, O. G.; Garriott, O. K.; Da Rosa, A. V. (Stanford Univ., Calif.). Planet. Space Sci.; 18: 159-70(Feb 1970).

Measurements of the total columnar electron content of the plasmasphere up to the plasmapause have been made using the beacon transmitters aboard the geostationary satellite ATS-III. The technique employed is a combination of the differential Doppler frequency and the Faraday rotation angle methods. Such a combination permits the determination of the integration constant necessary to convert differential Doppler data into information about the absolute value of the columnar content. A "layer shape factor" defined as the ratio between the Faraday rotation angle and the columnar content is also determined. The diurnal behavior of this factor can yield information on the exchange of ionization between the ionosphere and the protonosphere. This paper describes the analysis used to obtain both the absolute value of content and the shape factor. (auth) (UK)

30209 COMPLEX STUDIES OF POLAR IONOSPHERE. Evlashin, L. S. Akad. Nauk SSSR, Mezhdunar. Geofiz. Kom., Polyar.-Siyaniya; No. 17, 5-20(1968). (In Russian).

Results are presented of simultaneous observations on a vertical sounding station and by riometers operating on several frequencies, of the state of ionosphere, of the variations of the electromagnetic field of the Earth, and of the intensity of the spatial position and spectrum of aurorae. Also discussed is the spatial connection of electric currents in the ionosphere, aurora and ionospheric inhomogeneities (E_s layer and the region of the enhanced ratio waves absorption). The frequency dependence of absorption of cosmic-radio emission and its variants depending on the form of aurora and on the depth of penetration of ionizing radiation are analyzed. The relative intensity of streams of auroral protons and electrons is evaluated. The microstructure of geomagnetic disturbances connected with active and quiet forms of aurorae are discussed. (auth) (Meteorol. Geoastrophys. Abstr.)

30210 AURORA BAND DURING MAGNETIC DISTURBANCES. Starkov, G. V.; Fel'dshtein, Ya. I. Akad. Nauk SSSR, Mezhdunar. Geofiz. Kom., Polyar.-Siyaniya; No. 17, 22-33(1968). (In Russian).

According to the askafilms of the C-180 cameras, the position of the auroral band was determined for four time intervals centered at 20, 4, 8, and 16 hr local geomagnetic time depending on the level of magnetic activity. The indices Q, Q_p, and K_p were used to characterize magnetic disturbance. The values of changes of the auroral bandwidth at these time intervals with the magnetic activity variations were obtained. The scheme of the auroral band at different Q indices is presented and it is shown that an evening-morning asymmetry is observed and is expressed in the different width of the corresponding parts of the Earth and in the different distances of the latter from the pole. This asymmetry is maintained at any level of magnetic activity. A flattening of the auroral band is observed on the dayside, which is most prominent during high magnetic disturbances. It is also indicated that the auroral band during low magnetic activity can have breaks on the morning and evening sides. The probability of such breaks is reduced with the increase of magnetic disturbance. With $Q \geq 3$, a uniform auroral band can be expected. The presence of the breaks is supported by the synoptic map of aurorae. (auth) (Meteorol. Geoastrophys. Abstr.)

30211 INFLUENCE OF MAGNETIC ACTIVITY ON THE HEIGHTS OF AURORA. Starkov, G. V. Akad. Nauk SSSR, Mezhdunar. Geofiz. Kom., Polyar.-Siyaniya; No. 17, 39-43(1968). (In Russian).

Results are analyzed that indicate the heights of aurorae that diminish with the increase of magnetic activity. The increase of the vertical stretch with the decrease of magnetic activity is observed for ray forms. The dependence is obtained between the energy of electrons, corresponding to the average value of height of the lower edge of aurora, on the magnitude of the K_p index. (auth) (Meteorol. Geoastrophys. Abstr.)

30212 AURORAL PULSATIONS. Roldugin, V. K. Akad. Nauk SSSR, Mezhdunar. Geofiz. Kom., Polyar.-Siyaniya; No. 17, 44-9(1968). (In Russian).

Auroral pulsations of the Pi1 type, unlike Pi2, are caused not by variations of arcs and bands, but by the surrounding background. The diurnal changes of Pi1 pulsation intensity differ from the diurnal changes of auroral intensity. Pulsations were observed in the infrared region that were not accompanied by the glow in the visible region of the spectrum. A conclusion is made about the different mechanisms causing pulsating and nonpulsating auroral forms. (auth) (Meteorol.Geoastrophys. Abstr.)

30213 AURORA DURING THE MINIMUM AND MAXIMUM CYCLE OF SOLAR ACTIVITY. Fel'dshtein, Ya. I.; Lukina,

L. V.; Shevnina, N. F. Akad. Nauk SSSR, Mezhdunar. Geofiz. Kom., Polyar.-Siyaniya; No. 17, 50-8(1968). (In Russian).

A comparison was made of aurora in the years of the maximum (IGY) and minimum (IQSY) cycle of solar activity. It was found that (1) although the level of solar activity was greatly reduced, aurora on the nightside on the latitude of the oval auroral zone continue to appear, practically without interval; (2) the central line of the oval zone during IQSY was only slightly shifted in the night hours towards the pole (~1.5°); (3) with relatively similar intensity, planetary magnetic disturbances ($K_p = 5$), the region of latitude covered by aurora on the nightside of the Earth in the IGY stretches to less than Φ'; and (4) certain statistical regularities in aurora are in good correlation with the oval form of the auroral zone during the IQSY period; this form is analogous to the one suggested earlier for the IGY. The regularities mentioned are the diurnal variations in the auroral occurrences; latitude distribution of the number of aurorae at different hours of local time; diurnal shifts of the auroral region along the meridian; and changes of orientation of elongated forms of aurorae. A map shows isoaurorae (lines of equal number of occurrences in the zenith for the IQSY period). (auth) (Meteorol. Geoastrophys. Abstr.)

30214 PROCESSES IN THE IONOSPHERE RELATED TO THE CHANGES OF AURORA HEIGHTS. Sukhoivanenko, P. Ya. Akad. Nauk SSSR, Mezhdunar. Geofiz. Kom., Polyar.-Siyaniya; No. 17, 61-3(1968). (In Russian).

The relation of the heights of aurorae during several hours in March 1965 to the intensity of λ4278Å emission, radiowave absorption at 32 MHz, and Earth current pulsations is discussed. (auth) (Meteorol. Geoastrophys. Abstr.)

30215 EFFECT OF QUASI-RHYTHMICITY IN A NUMBER OF PHENOMENA OF GEOMAGNETISM AND AERONOMY. Tsirs, G. P. Akad. Nauk SSSR, Mezhdunar. Geofiz. Kom., Polyar.-Siyaniya; No. 17, 64-78(1968). (In Russian).

Bursts of ulf emissions, bursts of some geomagnetic disturbances, bursts of auroral absorption, and bursts of the uhf field, observed with the riometer, often form successions (quasi-rhythmoids), so that the greatest ratio of the neighboring ti intervals between the commencements of bursts is within 1.00 to 1.12, or 1.38 to 1.74. The problem of the physical meaning of this empirical effect is discussed. (auth) (Meteorol. Geoastrophys. Abstr.)

30216 GEOMAGNETIC DISTURBANCES IN HIGH LATITUDES IN JUNE 1965. Kuz'min, I. A. Akad. Nauk SSSR, Mezhdunar. Geofiz. Kom., Polyar.-Siyaniya; No. 17, 99-110(1968). (In Russian).

Results are presented of researches of the electron currents, precipitating into the lower ionosphere, that are registered by the decelerating x-ray emission with centers on balloons, and of their relations with geomagnetic disturbances and riometric absorption. The spatial relation of the region of electron precipitation with the electric currents in the ionosphere and with the region of anomalous absorption is discussed and it is shown that two types of electron precipitation are associated with quiet and active forms of aurora. (auth) (Meteorol. Geoastrophys. Abstr.)

30217 LATITUDE DEPENDENCE OF IONOSPHERIC PARAMETERS. Kolobova, A. P.; Los, B. P.; Rapoport, Z. Ts. Akad. Nauk SSSR, Mezhdunar. Geofiz. Kom., Polyar.-Siyaniya; No. 17, 116-26(1968). (In Russian).

The data of ionospheric stations in Murmansk, Rugozero, and Leningrad for 1962 to 1963 are analyzed. The critical frequencies of the regular layers (f_0F2 and f_0E) at these stations in the day hours change in accordance with the change of the zenith distance of the Sun and increase with the decrease of latitude. In the nighttime, the f_0F2 variations are less regular than during the day; the inhomogeneity of the ionosphere increases and the ionization changes irregularly on the layer E level (~100 km), as well as the radio wave absorption. The E_s layer of the r-type in the auroral zone is caused by corpuscular radiation. The energy spectrum of particles causing this layer is wide; as the latitude decreases, it becomes narrower. The number of occurrence of E_s of the f-type increases with the decrease of latitude. During the ionospheric magnetic disturbances, phenomena typical for the auroral zone are observed at lower latitudes and shift in E and F layers to lower latitudes than in the D layer. (auth) (Meteorol. Geoastrophys. Abstr.)

30218 U-LIKE FORMS OF AURORA. Zaitseva, S. A. Akad. Nauk SSSR, Mezhdunar. Geofiz. Kom., Polyar.-Siyaniya; No. 17, 34-8(1968). (In Russian).

The peculiarities of excitation and development of U-like auroral bands and their relation to the level of magnetic activity and configuration of current systems in the lower ionosphere are discussed. (auth) (Meteorol. Geoastrophys. Abstr.)

30219 MAGNETIC ACTIVITY IN HIGH LATITUDES OF NORTHERN HEMISPHERE IN THE PERIOD OF MAXIMUM AND MINIMUM OF SOLAR CYCLE. Afonina, R. G.; Fel'dshtein, Ya. I. Akad. Nauk SSSR, Mezhdunar. Geofiz. Kom., Polyar.-Siyaniya; No. 17, 139-64(1968). (In Russian).

The results are presented of the analysis of the space–time distribution of intensity of geomagnetic disturbances in the IGY–IQSY periods, with the help of equivalent ranges of K indices according to the data from the high-latitude observatories of the northern hemisphere. This analysis is premised by a summary of the main regularities of magnetic activity in high latitudes, obtained with the K index application. The results obtained are as follows: (1) At $\Phi' \geq 70°$, the magnetic activity remains at high level also in the years of minimum solar activity cycle; (2) the region of the maximum values r_K in the coordinate system "corrected geomagnetic latitude–geomagnetic time" is of an oval form, located in higher latitudes by day and in lower ones at night; and (3) with the increase of K_p, the region of the maximum disturbance is removed to the lower latitudes, but in all cases it preserves an oval form. The displacement of the oval of the maximum magnetic disturbance agrees well with the dynamics of the auroral belt. (auth) (Meteorol. Geoastrophys. Abstr.)

30220 ELECTROMAGNETIC FIELDS AND WAVES. SECOND EDITION. Lorrain, Paul; Corson, Dale R. San Francisco; W. H. Freeman and Company (1970). 729p. $15.00.

Vectors are discussed as an introduction. Electrostatic fields, both in a vacuum and in dielectrics, are discussed. The solutions of Laplace's and of Poisson's equations are covered. A short exposition of the basic concepts of special relativity, with little reference to electric charges, is presented. A demonstration of Maxwell's equations that is based on Coulomb's law and on the Lorentz transformation is given. For the sake of simplicity, it is assumed that the charges move at constant velocity. The conventional approach to the magnetic fields associated with constant and with variable currents is dealt with. A discussion of magnetic materials that parallels, to a certain extent, that on dielectrics is included. The Maxwell equation for the curl of B is rediscovered, without using relativity. This is followed by a discussion of the four Maxwell equations, as well as some of their more general applications. Various applications of Maxwell's equations are covered: plane waves in infinite media, reflection and refraction, guided waves, and radiation. The only three media considered are perfect dielectrics, good conductors, and low-pressure ionized gases. Attention is confined to the two simplest types of guided wave, namely the TEM mode in coaxial lines and the $TE_{1,0}$ mode in rectangular guides. Electric and magnetic dipoles and quadrupoles are discussed, as well as the essential ideas concerning the half-wave antenna, antenna arrays, and the reciprocity theorem. (M.H.R.)

30221 COMPARISON OF SIMULTANEOUSLY OBSERVED ELECTRON FLUXES LEAKED FROM THE OUTER RADIATION BELT AND VERY-LOW-FREQUENCY NOISES. Malyshev, A. B.; Svidskii, P. M.; Burov, V. A.; Kleimenova, N. G.; Troitskaya, V. A.; Vigneron, J.; Talino, I. Kosm. Issled.; 7: 941-4 (1969). (In Russian).

The preliminary data obtained during the simultaneous observation of high-energy electron fluxes from the external radiation belt and the 0.5- to 10-kHz "whistler" emission recorded at the interconnected subauroral stations of Sogra Kergelen, at a geomagnetic latitude of 57°, were examined. The electron flux data were obtained by instruments mounted on satellites which passed through the outer radiation zone in the drift-shell region at altitudes of 220 to 1150 km, measuring electron energies above 1.5 MeV and bremsstrahlung above 0.2 MeV during the period from July 2 to 11, 1965. A magnetic storm was observed during this period, followed by strong variations in the maxima of the radiation belt during the following days. Periods of normal, "catastrophic" and slight leakage of electrons could be discerned during the time of study. The vlf noises were recorded during the same period at the Sogra geophysical station. No correlation was found between the magnetic storm and the strong "whistlers." It was found that the wide-spectrum vlf noise with a frequency from 1.5 to 9 kHz corresponds to the catastrophic outleakage of electrons. In explanation, it is pointed out that removal of the electrons is due to the interaction with vlf waves in the plasma of the magnetosphere. Change of the pitch angles results in the entry of the captured electrons into the loss cone, resulting in the outleakage of the captured electrons. There is thus a definite correlation between the vlf whistlers and dynamic processes within the outer radiation shell. (TTT)

30222 SPECIFIC OSCILLATIONS OF THE MAGNETOTAIL OF THE EARTH. Ershkovich, A. I. Kosm. Issled.; 7: 944-7 (1969). (In Russian).

Hydromagnetic waves in an ideally conducting plasma may be viewed as transverse oscillations of elastic strings, representing the magnetic lines of force. This approach was used for the study of the magnetotail, considering it as a beam of string-like lines of force, one end of which is connected to the Earth and the other solidified by the unperturbed solar wind. The calculations indicated that as a result of collisions on the lateral surface of the tail, caused by changes of the velocity vector of the solar wind or shock waves generated during solar flares and the rotation of the Earth, the magnetotail undergoes oscillations with a total energy of $E \sim 10^{21}$ to 10^{22} erg. If the process is disturbed by a nonlinear mechanism, all of the energy stored in the tail may be released within the internal magnetosphere with a time characteristic of $\tau \sim 10^4$ seconds. Consumption of the rotational energy does not cause any noticeable slowing down of the revolution of the Earth. There is thus a potential correlation between the excitation of magnetic substorms and the specific oscillations of the magnetotail. (TTT)

30223 MEASUREMENT OF THE ENERGY SPECTRA OF ELECTRON FLUXES IN THE UPPER ATMOSPHERE AT INTERMEDIATE LATITUDES. Antonova, L. A.; Ivanov-Kholodnyi, G. S.; Medvedev, V. S. Kosm. Issled.; 7: 948-9(1969). (In Russian).

Most of the information concerning electron fluxes with energies of $\gtrsim 1$ keV in the upper atmosphere have been obtained at polar stations where the effect is most marked; therefore, measurements were carried out to determine the energy spectrum and flux of 1- to 20-keV electrons in the upper atmosphere at intermediate latitudes. Instead of the previously employed absorbers of varying thickness, an electrostatic deflecting field was used to separate various portions of the electron energy spectrum. When placed in front of the secondary electron multiplier, this system eliminates the effect of the visible and ultraviolet radiations. The flux of the 1-keV electrons during the night at periods of surge was estimated at $I \approx 10^6$ electrons/cm^2 · sec · sterad, corresponding to an energy flux of 2×10^{-3} erg/cm^2 · sec · sterad. On the basis of the sensitivity of the measuring system it was estimated that, under unperturbed conditions during the night, the energy flux does not exceed 10^{-2} erg/cm^2 · sec · sterad. (TTT)

30224 MEASUREMENT OF THE SOFT-ELECTRON ENERGY FLUX IN THE UPPER ATMOSPHERE AT INTERMEDIATE LATITUDES DURING THE NIGHT. Kazachevskaya, T. V.; Koryagin, A. I. Kosm. Issled.; 7: 950-2(1969). (In Russian).

A meteorological rocket was used to measure the energy flux of electrons with $E \geq 1$ keV at altitudes ranging from 80 to 165 km during the night of July 31, 1968 at an intermediate latitude within the Soviet Union. A thermoluminescent phosphor consisting of $CaSO_4$–Mn was used to measure the energy of the soft electrons. The viewing angle of the instrument was about 1.5 sterad. It was found that the signal varied with the altitude from 1×10^6 to 5×10^6 quanta/cm^2 · sec · sterad. The decrease of the signal at altitudes of $h < 127$ km was attributed to the absorption of the radiation in the atmosphere. The integral energy flux for $E \geq 5$ keV amounted to 1.1×10^{-3} erg/cm^2 · sec · sterad, determined with an error of 50%. The nighttime flux was thus found to be 100 times lower than the previously measured daytime flux. Slight occasional variations within periods of about 20 seconds were also noted. (TTT)

30225 VISCOUS MAGNETOPAUSE. Cassen, Patrick (Ames Research Center, Moffett Field, Calif.); Szabo, John. Planet. Space Sci.; 18: 349-66(Mar 1970).

Under the assumption that wave–particle interactions cause a hydromagnetic viscosity, the authors represent the magnetopause by the mixing region of two streams of plasma with different velocities and different magnetic fields (the magnetosheath flow and the magnetospheric convection). The plasma is considered to be compressible, with nonzero viscosity, thermal conductivity, and resistivity. Solutions are found for the variations of velocity, magnetic field, and temperature through the boundary layer. The case in which the field direction reverses across the current sheet is compared to that in which it does not. It is found that the behavior of the boundary layer is consistent with the following observations: (a) The magnetopause usually looks like a tangential discontinuity, but sometimes is abnormally thick and may possess a significant normal magnetic-field component. (b) Low-energy cosmic-ray particles frequently enter the magnetosphere along geomagnetic field lines connected directly to the interplanetary field. (c) Geomagnetic activity is generally (but not always) higher when the interplanetary field has a south pointing component than when it does not. (d) Geomagnetic activity is generally higher when the solar-wind Alfvén number is low than when it is high. (auth) (UK)

30226 LUNI-SOLAR TIDES IN H AT STATIONS WITHIN THE EQUATORIAL ELECTROJET. Rastogi, R. G.; Trivedi, N. B. (Physical Research Lab., Ahmedabad, India). Planet. Space Sci.; 18: 367-77(Mar 1970).

Lunar daily (L) variation at fixed lunar ages and lunar monthly (M) variation at individual solar hours of the horizontal magnetic field, H, at stations close to the magnetic equator for the IGY–IGC period are described. Chapman's (1919) phase law for the lunar daily variation is shown to be valid for any of the stations. The daily variations of the amplitude of lunar semi-monthly (M_3) tide is very similar to the corresponding S_q(H) variation. The yearly mean amplitude of L_2 or noon M_2 tide at different stations is directly proportional to the solar diurnal range of H. The phase of M_2 tide for the daytime hours at any of the stations occurs at the same lunar time (τ) in D months and at the same lunar age (ν) in J months. These results indicate an intimate relation between the lunar tides at the equatorial stations with the electrojet currents in respect to the diurnal as well as longitudinal variations. (auth) (UK)

30227 THE HM WAVE–PARTICLE CYCLOTRON RESONANCE FOR NON-PARALLEL PROPAGATION. Dobes, K. (Geophysical Inst., Prague). Planet. Space Sci.; 18: 395-406(Mar 1970).

Using the direct calculation of power absorption due to the cyclotron resonance interaction with energetic particles the growth rate of HM-waves corresponding to Pc-1 geomagnetic pulsations is derived. The HM-waves are assumed to be propagated obliquely with respect to the external magnetic field. The expression for a wave growth rate allows an arbitrary particle velocity distribution to be applied. For the mono-energetic pitch-angle distribution of protons the two-dimensional graphs of the growth rate γ vs. the normalised wave frequency $\nu = \omega/\Omega_1$ and the propagation angle Θ show the remarkable difference between the parallel and nonparallel cases. (auth) (UK)

30228 MAGNETOSPHERIC CONVECTIONS AND DAMPED-TYPE GEOMAGNETIC PULSATIONS ASSOCIATED WITH STORMS. Namikawa, Tomikazu; Matsushita, Sadami (National Center for Atmospheric Research, Boulder, Colo.). Planet. Space Sci.; 18: 407-15(Mar 1970).

It is shown that the steady magnetospheric motion generated by the solar wind is current-free in the first approximation, regardless of the driving mechanism. Also the sufficient condition for the hydromagnetic stability of cold plasma in the presence of an external magnetic field and a steady motion is obtained. Based on these theoretical estimations the damped-type geomagnetic pulsations associated with geomagnetic storms are interpreted as an interaction between hydromagnetic oscillations and magnetospheric motions caused by solar winds. (auth) (UK)

30229 VARIATION OF THE ION-TEMPERATURE GRADIENT ALONG FIELD LINES IN THE OUTER PLASMASPHERE. Grebowsky, J. M.; Rahman, N. K. (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci., 18: 417-22(Mar 1970).

The equations of thermal diffusion are used to explore the variation of the ion-temperature in the outer plasmasphere, where H^+ is the dominant positive ion. The ion-temperature gradient component in the direction of the magnetic field is a function of only the ratio of the H^+ scale height to the He^+ scale height along the field direction and the gravitational acceleration when the ion and electron temperatures are equal. However, if the scale heights are equal then the ion-temperature gradient is independent of the temperature and depends only on the gravitational acceleration. The ion-temperature gradients are determined throughout the plasmasphere where the H^+, He^+ concentration ratio is assumed to be spatially invariant. At an altitude of 1000 km in the protonosphere, the magnitude of the computed upward directed ion-temperature gradient component along the field line increases from 0.9°K/km near $L = 1.3$ to 1.5°K/km at $L = 5$. The computed ion-temperature variations are in general agreement with electron-temperature observations in the topside ionosphere and the outer plasmasphere. (auth) (UK)

30230 JOULE HEATING AND THE EXCITATION OF THERMOTIDAL MODES IN THE DYNAMO REGION. Stening, R. J. (Univ. of Queensland, St. Lucia, Australia). Planet. Space Sci.; 18: 423-30(Mar 1970).

An estimate is made of the heat input into the dynamo region of the ionosphere (1) from solar radiation and (2) from Joule heating and the coupling of these inputs to various thermotidal modes is calculated. The Joule heating is found to have a large semi-diurnal component at high latitudes at the solstice and also an increase in magnitude at the dip equator. Some consideration is given to semi-annual effects arising from these heating processes. (auth) (UK)

30231 PHOTOMETRIC AND INTERFEROMETRIC OBSERVATIONS OF A MID-LATITUDE STABLE AURORAL RED ARC.

Roble, R. G.; Hays, P. B.; Nagy, A. F. (Univ. of Michigan, Ann Arbor). Planet. Space Sci.; 18: 431-9(Mar 1970).

Observational results of the midlatitude stable auroral red arcs of October 30/31 and October 31/November 1, 1968 are presented. The measurements were made with a turret photometer and a 6 in. dia. high resolution, pressure scanning Fabry–Perot interferometer. The structure, intensity, and position of the red arc were determined from photometer scan measurements which show that the arc was stable, persisted for more than 12 hr, and moved southward during the night. The arc appeared to extend across the eastern part of the United States tilted to lines of constant magnetic L shells. The results of the Doppler temperature measurements made with the Fabry–Perot interferometer show no measurable neutral gas temperature increase within the red arc. (auth) (UK)

30232 DISPERSION OF WAVES IN THE LOWER EXOSPHERE WITH MULTIPLE IONIC SPECIES. Hayakawa, Masashi; Ohtsu, Jinsuke; Iwai, Akira (Nagoya Univ., Toyokawa, Japan). Rep. Ionosphere Space Res. Jap.; 23: 233-46(Dec 1969).

Group propagation in a multicomponent plasma is investigated, with special reference to the lower exosphere. As a numerical example, exospheric conditions at altitudes 500, 1000, and 2000 km are considered. First, the frequency dependence of group velocity of various modes is studied for the altitudes, and the dispersion of modes is examined. Secondly, the trapping characteristics of modes due to magneto-ionic ducting are studied in each frequency region for altitude 2000 km. (auth)

30233 VELOCITY DISTRIBUTION FUNCTION FOR ELECTRONS IN THE IONOSPHERE IN THE PRESENCE OF ELECTRIC AND MAGNETIC FIELDS. PART 1. EFFECT OF AN OSCILLATING ELECTRIC FIELD. Iso, Akio; Kamiyama, Hiroshi (Tohoku Univ., Sendai). Rep. Ionosphere Space Res. Jap.; 23: 247-69 (Dec 1969).

The solution is obtained to the Boltzmann equation for the electron velocity distribution in a weakly ionized air under the following assumptions: (1) An oscillating electric field with a constant amplitude in a given direction is imposed in an ionized air in which a static magnetic field can be considered to be uniform. (2) Electrons may lose their energies in elastic and inelastic collisions with neutral particles, resulting in rotational excitations of molecules and changes in electron energies. (3) Electrons are not in the thermal equilibrium with neutral particles, the average electron energy being larger than the mean thermal energy of a neutral particle. The distribution function is given, in general, as a function of the electric field imposed, its oscillating frequency, the strength of a magnetic field, and the density and the composition of the air. Based on the result, an attempt is made to estimate the electron temperature in the ionosphere for some restricted cases. A discussion is given of the frequency limit below which the treatment based on an oscillating electric field is not adequate to give the distribution function. After deriving an expression for the velocity distribution in a quasi-stationary state, the present study suggests that the electron temperature is strongly dependent on the strength and the orientation of an electric field with respect to the magnetic field, and on collision processes of electrons. (auth)

30234 ENERGY SPECTRUM AND PITCH ANGLE DISTRIBUTION FOR TRAPPED PARTICLES RESULTING FROM THE INWARD DIFFUSION DUE TO THE THIRD INVARIANT VIOLATION. Watari, Nobuo; Kamiyama, Hiroshi (Tohoku Univ., Sendai). Rep. Ionosphere Space Res. Jap.; 23: 270-80(Dec 1969).

Based on a model in which particles injected into the outer magnetosphere are transported to the inner region due to the violation only of the third adiabatic invariant, a theoretical study is made on the energy spectrum and the equatorial pitch-angle distribution for high-energy particles (protons and electrons) trapped in the magnetosphere. The result is qualitatively in good agreement with the observations during magnetically quiet periods. From the present study, the following are strongly suggested: (1) The L value of the shell in which particles are injected may be about 10. On this shell, the e-folding energy of the spectrum ranges from 10 to 15 keV for protons and from 10 to 50 keV for electrons. (2) The main injection region is located near the equatorial plane. (3) On inner shells, the pitch-angle distribution depends upon the energy. (4) The spatial variations in the intensity and the pitch-angle distribution suggest that the loss of protons is relatively important in the inner magnetosphere ($L < 3$) due to a mechanism depending on the equatorial pitch angle, while electrons are lost due to scattering processes that are independent of the energy. The differences between the energy spectra and the pitch-angle distributions for protons and for electrons are ascribed to different loss processes. (auth)

30235 WORLDWIDE CHARACTERISTICS OF GEOMAGNETIC PC-PULSATIONS WITH THE PERIOD FROM 10 TO 150 SECONDS DURING ACTIVE-SUN YEARS. Hirasawa, Takeo (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 23: 281-93(Dec 1969).

An attempt was made to get the average dependence of pc periods on geomagnetic latitude by using the IGY data obtained at 13 stations distributed from high to low latitudes. It was found that there is a distinct dependence of pc period on geomagnetic latitude. Referring to this result, it is reasonable to classify the geomagnetic pc pulsations (pc 4 and pc 3 range, 10 to 150 sec in period) into four kinds: i.e., (A) polar pc, (B) middle-latitude pc, (C) submiddle-latitude pc, and (D) short-period period pc. The diurnal tendencies of each type of pulsation are shown. Possible origin for geomagnetic pulsations of each type is also discussed. (auth)

30236 ISOPHOTO-MAPS OF [OI] 6300 A AIRGLOW BEFORE DAWN. Misawa, Kiyotoshi (Tohoku Univ., Sendai); Okuda, Mitsunao. Rep. Ionosphere Space Res. Jap., 23: 294-5(Dec 1969).

Isophoto-maps of [O I] 6300 Å airglow in the predawn were studied with attention to their seasonal difference. It was concluded that the predawn enhancement in winter is ascribed mainly to the photoelectrons precipitated from the conjugate ionosphere, whereas in summer it is due to the photoelectrons produced by solar euv. (W.D.M.)

30237 TIME-VARIATION OF [OI] 6300 A AIRGLOW IN THE POSTDUSK HOUR. Okuda, Mitsunao (Hirosaki Univ., Japan); Misawa, Kiyotoshi. Rep. Ionosphere Space Res. Jap.; 23: 296-8(Dec 1969).

Isophoto-maps were drawn to examine the time variation of the 6300 Å airglow intensity during the postdusk hours at Tohkatta. No enhancement comparable to the predawn enhancement was found. (W.D.M.)

30238 IONIC CONSTITUTION OF CLASS I AURORAS. Swider, W. Jr.; Narcisi, R. S. (Air Force Cambridge Research Labs., Bedford, Mass.). Planet. Space Sci.; 18: 379-85(Mar 1970).

Ionic composition calculations for class I auroras match the data if an $[O]/[O_2]$ ratio 2 to 4 times the 1965 CIRA atmospheric model is adopted. This conclusion is dependent upon the accuracy of the assumed O^+ ion loss rates and whether or not there is some enhancement of NO and/or N in the auroral E region. A combination of these factors may be involved. Dissociative recombination temperature dependencies recently suggested by others appear to produce results for NO^+ and O_2^+ ions which fit the observational data better than other functions presently in use. (auth) (UK)

30239 ANALYTIC SOLUTIONS TO TWO ALBEDO PROBLEMS. Noerdlinger, Peter D. (New Mexico Inst. of Mining and Tech., Socorro). J. Math. Phys. (N. Y.); 11: 1735-7(May 1970).

A random walk approach leads to rigorous solution of certain albedo problems usually solved by Monte Carlo techniques or other numerical methods. (auth)

30240 COMPUTATIONS OF MODE-SCATTERING COEFFICIENTS DUE TO IONOSPHERIC PERTURBATIONS AND COMPARISON WITH VLF RADIO MEASUREMENTS. Bahar, E. (Univ. of Colorado, Boulder). Proc. Inst. Elec. Eng. (London); 117: 735-8(Apr 1970).

Computations of mode-scattering coefficients arising from ionospheric perturbations at sunrise and sunset lines are reported. The computations are based on an analysis that exploits the concept that radio waves at low frequencies propagate in a nonuniform, spherical, "Earth–ionosphere waveguide" with finite, surface-impedance boundaries. The computed data are compared with available experimental data at 18 kHz for both day–night and night–day propagation paths. The computed data for vlf radio frequencies indicate that, for an ionospheric effective-height change of 20 km, the magnitudes of the first-second and second-first mode-conversion coefficients pass through minima about 16 kHz provided that the length of the transition region is less than 800 km. (auth) (UK)

30241 INTENSITIES OF NIGHTGLOW DURING SUNSPOT MIMINUM ACCORDING TO MEASUREMENTS MADE IN SOUTH-WEST AFRICA. PART 2. DISCUSSION OF THE RESULTS AND COMPARISON WITH IONOSPHERIC OBSERVATIONS. Dachs, J. (Tuebingen Univ., Ger.). Beitr. Phys. Atmos.; 41: 184-215(1968). (In German).

Results of nightglow intensity observations obtained at Tsumeb (South West Africa) at wavelengths 3914, 5577, 5890, 6300, and 7273 Å are discussed. The nightly intensity variations of the O I airglow emissions at 5577 and 6300 Å are related to vertical

movements in the ionospheric E and F layers, derived from observations of the critical frequencies and heights of the ionosphere above Tsumeb. Four types of nightly 5577 Å intensity variations are described. The seasonal variation of this emission is compared to density variations in the upper atmosphere. In 85% of the nights, the intensity of the O I 6300 Å emission shows the equatorial behavior with a maximum around midnight. In the southern winter, pre-dawn enhancements at 6300 Å are observed to start sometimes as early as one hour before the beginning of local astronomical twilight. Intensity variations during geomagnetic storms are discussed. (auth) (Meteorol. Geoastrophys. Abstr.)

30242 ELECTROMAGNETIC PROBING OF THE UPPER ATMOSPHERE. Gordon, W. E. (Rice Univ., Houston, Tex.). J. Atmos. Terrest. Phys.; 32: 459-66(Apr 1970).

The International Union for Radio Science (URSI) established a Working Group in the spring of 1968 to make a critical study of electromagnetic probing of the upper atmosphere. The purposes of the study were to reexamine the theoretical grounds upon which the probing techniques depend, to assess the current limits of observational practices, to compare the results obtained by various techniques, to comment on the existence of, or need for, networks of observing stations, and to consider the relevance of the probing techniques to aeronomy. This paper and the following paper by Booker on the intercomparison of techniques, plus the manuscripts prepared on behalf of the eleven working parties that follow, comprise the report of the Working Group. Each member of the Working Group organized and chaired a working party. During the course of the study, the members of the Working Group were particularly stimulated by J. Sayers' discussions and understanding of the problems associated with in situ probes, were concerned about the small number of, but important need for, meaningful intercomparisons of different techniques, were impressed by the important roles of rocket-borne probes in the height interval 70 to 100 km and of the incoherent scatter technique above 100 km to provide the observations needed to attack the outstanding problems in aeronomy, and were concerned about the lack of suitable probes below about 70 km. (auth) (UK)

30243 COMPARATIVE STUDY OF IONOSPHERIC MEASUREMENT TECHNIQUES. Booker, Henry G. (Univ. of California, San Diego); Smith, Ernest K. J. Atmos. Terrest. Phys.; 32: 467-97(Apr 1970).

Comparisons are presented between different methods of measuring ionospheric profiles of electron density, electron temperature and ion temperature. The methods compared are listed for the upper ionosphere (above 100 km) and for the lower ionosphere. Only comparisons involving closely simultaneous observations near the same location are included. From 100 km down to perhaps 70 km, the radio rocket method appears to have the greatest accuracy. Nevertheless, the ground-based partial reflection and wave-interaction methods need to be developed for continuous observation of electron-density profiles. Moreover, other methods are valuable for monitoring purposes. Above 100 km, satellite methods, particularly the topside ionosonde, are important for obtaining global coverage. But for accuracy of measurement of electron density, electron temperature, ion temperature (and several other aeronomically vital parameters), ground-based methods, particularly the incoherent scatter radar, are superior in the altitude range from one hundred to several hundred kilometers. In many respects, however, satellite and ground-based methods are complementary. (auth) (UK)

30244 IONOSPHERIC PROBING USING PULSED RADIO WAVES AT OBLIQUE INCIDENCE. Bradley, P. A.; Eccles, D.; King, J. W. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys.; 32: 499-516(Apr 1970).

Four different ionospheric probing techniques, all of which use pulsed radio waves at oblique incidence, are discussed. These are: (a) the study of radio aurorae by means of auroral radar equipment in which the transmitter and receiver are situated at the same location, (b) meteor radar investigations of meteor trains and their movements, (c) high-frequency ground backscatter, in which radio waves reflected from the ionosphere are backscattered at the ground and return via the same path to the transmitter, and (d) variable-frequency oblique sounding. The type of ionospheric information that can be obtained using each of the four techniques, the limitations of the techniques, and the future research which needs to be done are considered. (auth) (UK)

30245 IONOSPHERIC PROBING WITH LONG WAVELENGTH RADIO WAVES. Crain, C. M. (Rand Corp., Santa Monica, Calif.). J. Atmos. Terrest. Phys.; 32: 551-66(Apr 1970).

Techniques of ionospheric probing using ground-based facilities and frequencies in the region from about 10 Hz to 100 kH are considered. Primary emphasis is placed on vlf and lf probing; however, some attention is given to the elf portion of the spectrum. The height regions of the lower ionosphere that potentially can be probed are examined in terms of various factors that determine the complex refractive index of the ionized medium. Measurement techniques and methods for data interpretation currently used for near vertical and oblique vlf/lf sounding are briefly described. Finally, a discussion of temporal and spatial resolutions obtainable by long-wavelength probing is presented. (auth) (UK)

30246 RADIO WAVE PROBING OF THE IONOSPHERE BY THE PARTIAL REFLECTION OF RADIO WAVES (FROM HEIGHTS BELOW 100 km). Belrose, John S. (Communications Research Centre, Ottawa). J. Atmos. Terrest. Phys.; 32: 567-96(Apr 1970).

The partial reflection of radio waves (frequencies 1.78 to 6.275 MHz were employed) from the lower ionosphere is a most valuable technique to study synoptically ionization changes in the D-region. The basic experimental measurement concerns the ratio A_x/A_0, of the relative amplitudes of the extraordinary and ordinary waves, as a function of height. According to the theory employed, which assumes, with reasonable theoretical justification that reflection is due to ionization irregularities ($\overline{\Delta N/N}$), this ratio provides a measure of the electron collision frequency in the height range where differential absorption is negligible (50 to 60 km during the daytime); and if the scale height of the atmosphere is assumed, the $A_x/A_0(h)$ provides a measure of the electron density in the height region where differential absorption can be measured (70 to 90 km). By employing two or more frequencies, and rather large antenna arrays, the electron density can be measured in the height range 50 to 90 km during the daytime (40 to 80 km at times when the ionization densities are abnormally high). The levels of noise and interference at middle latitudes restrict the times when reliable data can be obtained to daytime hours (the solar zenith angle $\chi < 70$ to 90°); but at high latitudes reliable data can be obtained throughout the day (i.e., during the night as well). (auth) (UK)

30247 RADIO-WAVE PROBING OF THE LOWER IONOSPHERE BY CROSS-MODULATION TECHNIQUES. Fejer, J. A. (Univ. of California, San Diego, La Jolla). J. Atmos. Terrest. Phys.; 32: 597-607(Apr 1970).

The potentialities of cross-modulation observations as a means of exploring the ionospheric D region are assessed. It is concluded that useful information on D-region electron densities and collision frequencies can be obtained by cross-modulation techniques; this has already been demonstrated by workers at Pennsylvania State University and the University of Armidale. Suggestions regarding the improvement of existing installations and the design of new installations are made. The desirability of simultaneous comparisons with partial reflection measurements at the same geographical location is stressed. (auth) (UK)

30248 USE OF ATMOSPHERICS FOR STUDYING THE IONOSPHERE. Horner, Frederick (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys.; 32: 609-21 (Apr 1970).

Observations of atmospherics can provide useful information about the lowest regions of the ionosphere and about the properties of the magnetosphere. They are unlikely to lead to explicit models of the lower ionosphere, but can provide a check on the validity of models deduced by other means. They are also of particular value in providing a convenient method of monitoring the ionosphere to detect the incidence of disturbed conditions. Recording of whistlers is an effective technique for determining electron densities in the magnetosphere. (auth) (UK)

30249 HF AND VHF ABSORPTION TECHNIQUES IN RADIO-WAVE PROBING OF THE IONOSPHERE. Mitra, A. P. (National Physical Lab., New Delhi). J. Atmos. Terrest. Phys.; 32: 623-46(Apr 1970).

A critical examination of the techniques of measurement of ionospheric absorption by hf and vhf radiowaves and the scientific significance of these measurements are presented. The techniques discussed include the use of (1) pulsed transmission with reflection from one of the ionospheric layers (A1 technique), (2) cosmic radio noise (A2 technique), (3) cw waves from commercial transmitters (A3 technique), and (4) f_{min}. For each technique the method of analysis, along with indication of its limitations and possible areas of improvement, is outlined. Discussions on the scientific relevance of the technique include: (a) the aeronomic implications of morphological analysis, such as those giving the dependence of absorption with frequency, with solar zenith angle and with solar activity, (b) the Winter anomaly in midlatitudes and the anomalous nature of equatorial absorption, (c) the ionospheric implications of flare effects in absorption, (d) recent attempts to develop electron density profiles from single or multifrequency absorption measurements and comparison of selected profiles with

those obtained by other techniques at similar latitudes and times, and (e) estimates of collision frequencies at E- and F-region heights and some recent attempts to obtain information on electron temperature. (auth) (UK)

30250 RADIO PROPAGATION EFFECTS USED ON ROCKETS IN PROBING THE IONOSPHERE. Maeda, Ken-ichi (Kyoto Univ.). J. Atmos. Terrest. Phys.; 32: 647-61(Apr 1970).

Following a brief history of the development of rocket measurement of electron density based on radio propagation effects, the principles of measurement are outlined. A variety of principles are available and descriptions are given for (1) Doppler frequency shift, (2) propagation phase and time, (3) Faraday rotation, (4) wave absorption, and (5) the use of cosmic radio waves. A comparative survey is made between this technique and the in situ probe measurement. Approximations involved in this technique and some specific features concerning the accuracy and limitation of each individual method, are explained. Finally, some comparisons of results obtained by this and other methods are given. Two tables showing the frequency bands used and the measurable height range for each method are also given. (auth) (UK)

30251 IN-SITU PROBES FOR IONOSPHERIC INVESTIGATIONS. Sayers, J. (Univ. of Birmingham, Eng.). J. Atmos. Terrest. Phys.; 32: 663-91(Apr 1970).

The measurement of most plasma parameters of the ionosphere in the E region and above by in-situ probes can be achieved with an accuracy in the region of 10% and in some cases much better than this. The measuring techniques that have been well established are rf impedance or capacitance probes and upper-hybrid-resonance probes for electron density measurements; modified Langmuir probes for electron temperature measurements; retarding-potential analyzers or sampling mass spectrometers for ion density measurements; quadrupole or monopole mass spectrometers for ion and neutral gas analysis; and retarding-potential analyzers for ion temperature measurements. In the D region and below, the relatively short mean free path presents serious problems for most measuring techniques and relatively few in-situ measurements can be made with confidence. Fixed bias conductivity probes can be used for electron and ion density measurements but they require calibration in-situ and the calibration factor varies with altitude. Mass spectrometers with pumps to increase the mean free path in the analyzing region at present offer the most satisfactory in-situ diagnostic instrument for the D region. In the magnetosphere local disturbance of the ambient electron population by spacecraft uv electron emission and by spacecraft electrostatic charges makes electron probing very difficult. The relative velocity of the ions due to spacecraft motion makes these particles less susceptible to such disturbances and ion retarding potential analyzers or mass spectrometers offer the best means of investigating the tenuous plasma of the magnetosphere. (auth) (UK)

30252 INCOHERENT SCATTERING AT RADIO FREQUENCIES. Farley, D. T. (Cornell Univ., Ithaca, N. Y.). J. Atmos. Terrest. Phys.; 32: 693-704(Apr 1970).

The current status of theory and observations of incoherent scatter from the ionosphere are discussed. Some examples of the more-important scientific advances that have resulted from incoherent scatter measurements are given. Comparisons of scatter data with data obtained by other techniques show good agreement in some, but not all cases. Where serious discrepancies arise, evidence suggests that the incoherent scatter data are probably the more nearly correct. The potential of incoherent scatter measurements for increasing our understanding of ionospheric physics is only beginning to be utilized. Some speculations as to future research and the ultimate practical capabilities of incoherent scatter measurements are given. (auth) (UK)

30253 ELECTRON CONTENT OBTAINED FROM FARADAY ROTATION AND PHASE PATH LENGTH VARIATIONS. Garriott, Owen K. (Manned Spacecraft Center, Houston, Tex.); Da Rosa, Aldo V.; Ross, William J. J. Atmos. Terrest. Phys.; 32: 705-27 (Apr 1970).

A critical study is made of electron content calculations made by measurements of polarization rotation and phase path length changes. The accuracies of the principal methods are examined for satellites in "low," eccentric, and geostationary orbits. Observed variation with local time, latitude, season, solar cycle, and in ionospheric storms are summarized. Finally, the relevance of these measurements to existing ionospheric problems is discussed. (auth) (UK)

30254 LASER RADAR STUDIES OF THE ATMOSPHERE ABOVE 50 km. Grams, G. W. (Electronics Research Center, Cambridge, Mass.). J. Atmos. Terrest. Phys.; 32: 729-36 (Apr 1970).

The results of laser radar techniques for probing the upper atmosphere are presented. These techniques are based on analyses of the light scattered from a laser beam by the various constituents of the atmosphere. Under appropriate conditions, the data obtained with laser radars may be related to the spatial distribution of various minor constituents, such as atmospheric aerosols and water vapor, as well as to vertical profiles of atmospheric density, temperature, and winds. (auth) (UK)

30255 NONLINEAR DYNAMICS OF FAST-ELECTRON INHOMOGENEITIES IN THE MAGNETOSPHERE. Gurevich, A. V.; Tsedilina, E. E. (Lebedev Inst. of Physics, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 660-7(1969).

Translated from Geomagn. Aeron.; 9: 818-27(1969).

Hydrodynamic equations are introduced that describe the dynamics of an inhomogeneous cloud of fast electrons trapped in the geomagnetic field. Its stability is investigated. The results of numerical computations for various values of the characteristic dimensionless parameter λ are presented. (auth)

30256 CYCLIC VARIATIONS OF ANOMALOUS F2 LAYER IONIZATION IN THE VICINITY OF THE GEOMAGNETIC POLE. Besprozvannaya, A. S.; Yudovich, L. A. (Arctic and Antarctic Scientific Research Inst., USSR. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 691-3(1969).

Translated from Geomagn. Aeron.; 9: 856-9(1969).

The cyclic variations with the solar activity cycle of anomalous F2-layer ionization in winter at polar stations in the northern hemisphere are examined. A "corpuscular addition" in critical frequencies and in maximum density at noon is distinguished. It is found that the ion production rate of anomalous ionization decreases from the solar activity maximum to the minimum. This also coincides with a decrease in the density of the low-energy solar plasma, which is possibly responsible for anomalous ionization. (auth)

30257 DEPENDENCE OF THE FREQUENCY CHARACTERISTICS OF THE E_s LAYER ON THE TECHNICAL PARAMETERS OF THE EQUIPMENT. Ovezgel'dev, O.; Kelov, K. (Inst. of Terrestrial and Atmospheric Physics, Ashkhabad, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 694-7(1969).

Translated from Geomagn. Aeron.; 9: 860-4(1969).

A method of investigating the dependence of the frequency characteristics of the E_s layer on the equipment parameters is analyzed. The allowable limits of variations in transmitter power and receiver gain are determined. (auth)

30258 NOON RECOVERY OF POLAR-CAP ABSORPTION. Driatskii, V. M. (Arctic and Antarctic Scientific Research Inst., USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 702-3 (1969).

Translated from Geomagn. Aeron.; 9: 870-2(1969).

The noon recovery of the PCA observed September 2–6, 1966, is examined. It was manifest in the auroral zones of the northern and southern hemispheres. The increase in the hardness of the ionizing flux during the noon recovery is confirmed. (auth)

30259 BREMSSTRAHLUNG OF HARD ELECTRONS DURING INTENSE AURORAS. Novikov, A. M.; Shafer, Yu. G. (Inst. of Cosmophysical Investigations and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 709-13 (1969).

Translated from Geomagn. Aeron.; 9: 880-6(1969).

The results of measurements of the X bremsstrahlung of hard electrons during intense auroras are compared with synchronous data on the absorption level of cosmic noise, the vlf radiation of the upper atmosphere, and with radio signal comparison data for high-latitude links. The region of injection of electron fluxes is determined and the spectrum of electrons observed at the time of appearance of diffuse, pulsating auroral forms is estimated. (auth)

30260 WIDTH OF BAND-SHAPED AURORAL FORMS. Nadubovich, Yu. A. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 714-18(1969).

Translated from Geomagn. Aeron.; 9: 887-93(1969).

The widths of band-shaped auroral forms were measured from all-sky camera films of stations in the northern hemisphere. The values of 8, 13, 17, and 22 km are most frequently encountered. In the auroral zone, the average width of auroras was 8 to 18 km, and changed inversely relative to the general auroral frequency. No systematic differences were noted in the width of homogeneous and rayed auroras. The auroral arcs and bands were widest at midnight hours and during the period of the winter solstice. (auth)

30261 GEOMAGNETIC STORM FAMILIES FROM 1957 TO 1964. III. RELATIONSHIP BETWEEN GEOMAGNETIC ACTIVITY AND VARIOUS MANIFESTATIONS OF SOLAR ACTIVITY. Afans'eva, V. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 723-5(1969).

Translated from Geomagn. Aeron.; 9: 899-902(1969).

Storm families of various degrees of activity have their own year-to-year distribution, similar to that of individual manifestations of solar activity. (auth)

30262 VARIABILITY AND TRAVELTIME OF THE GEOPHYSICALLY EFFECTIVE FLUX OF INTERPLANETARY PLASMA RESPONSIBLE FOR THE MAGNETOSPHERIC STORM OF APRIL 17–19, 1965. Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 732-3(1969).

Translated from Geomagn. Aeron.; 9: 913-14(1969).

Traveltime of the geophysically effective flux of interplanetary plasma responsible for the magnetospheric storm of April 17–19, 1965, is estimated, based on intuitive considerations. (W.D.M.)

30263 INFLUENCE OF THE INCLINATION OF GEOMAGNETIC LINES OF FORCE ON THE PROPAGATION OF GUIDED HYDROMAGNETIC WAVES IN THE LOWER IONOSPHERE. Van'yan, L. L.; Abramov, L. A. (Inst. of Terrestrial Physics, Moscow. Inst. of Space Research, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 733-5(1969).

Translated from Geomagn. Aeron.; 9: 914-16(1969).

The influence of the inclination of geomagnetic lines of force is examined without allowance for Hall conductivity. The oscillation period is assumed to be so great that one can neglect induction effects in the lower ionosphere. It is shown that the lower part of a geomagnetic force tube contributes most to the magnetic field of longitudinal currents to heights greater than 2γ, where γ is the distance along the Earth's surface from the base of the tube to the observation point. (W.D.M.)

30264 SCATTERING CONE OF HYDROMAGNETIC WAVES GUIDED BY THE MAGNETIC FIELD. Van'yan, L. L.; Yudovich, V. A. (Inst. of Terrestrial Physics, Moscow. Inst. of Space Research, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 736-8(1969).

Translated from Geomagn. Aeron.; 9: 917-19(1969).

It is concluded that in a plasma with a tensor there is a cone whose axis is the line of force on which the oscillating current element is located. The main part of the hydromagnetic emission guided by the magnetic field is transported within this cone and the intensity of the field components decreases at least in inverse proportion to the first power of distance. (W.D.M.)

30265 RESULTS OF CALCULATION OF IONIZATION OF THE ATMOSPHERE BY BETA PARTICLES FROM THE DECAY OF FISSION PRODUCTS. Bizunov, V. P.; Zykov, I. K. Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 738-40(1969).

Translated from Geomagn. Aeron.; 9: 920-1(1969).

The ionization of the atmosphere by electrons from β decay of fission products located at a height of 300 km is considered. The β particles enter the atmosphere from above, and the character of their motion is determined by the geomagnetic field. The profiles of the ionization intensity of the atmosphere for three instants of time after fission are calculated: 1.04, 18.9, and 298 sec. (W.D.M.)

30266 DYNAMICS OF MAGNETICALLY CONJUGATE REGIONS IN THE F2 LAYER OF THE IONOSPHERE. Ben'kova, N. P.; Bukin, G. V.; Kolokolov, L. E.; Lafeille, M.; Taieb, C.; Faynot, G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Centre National de Telecommunications, Paris). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 742-4(1969).

Translated from Geomagn. Aeron.; 9: 923-5(1969).

During the period of the Franco–Soviet study of the ionosphere in magnetically conjugate regions in Sept.–Oct. 1966, observations were made not only at permanent stations, but also from aircraft. The observations are summarized and conclusions are given. (W.D.M.)

30267 INFLUENCE OF MAGNETIC DECLINATION ON THE BEHAVIOR OF THE F2 LAYER AND RELATIONSHIPS BETWEEN CRITICAL FREQUENCIES, f_0F_2, AT TWO MAGNETICALLY CONJUGATE POINTS. Grosheva, N. M.; Pisareva, V. V. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 744-5(1969).

Translated from Geomagn. Aeron.; 9: 926-7(1969).

From results obtained (lack of f_0F2 correlation at two conjugate points in summer and winter) it is concluded that the winter anomaly of the critical F2-layer frequencies can hardly be associated with the transport of ionization from a magnetically conjugate point. Yet, during the equinoctial months there can be some relationship in the variations of $f_0F2(T)$ at two conjugate points. (W.D.M.)

30268 ESTIMATE OF THE RATIO OF DISSOCIATIVE RECOMBINATION COEFFICIENTS $\alpha_{O_2^+}/\alpha_{NO^+}$ ACCORDING TO TWO ROCKET EXPERIMENTS. Goncharov, L. P.; Shchepkin, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 745-7(1969).

Translated from Geomagn. Aeron.; 9: 928(1969).

On Jan. 26, 1966, ion concentration was measured in the upper atmosphere at $\chi = 103°$ (Johnson and Hulburt. IQSY, COSPAR, 1967. London, July 1967). An attempt is made to estimate the $\eta = \alpha_{O_2^+}/\alpha_{NO^+}$ ratio from the measurements of Johnson and Hulburt, assuming that α_{eff} = const. (W.D.M.)

30269 ESTIMATE OF IONOSPHERIC REACTION COEFFICIENTS THAT CORRELATE THE EQUATORIAL N(h) PROFILE AND JACCHIA'S MODEL OF THE NEUTRAL ATMOSPHERE. Goncharov, L. P.; Shchepkin, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 747-9(1969).

Translated from Geomagn. Aeron.; 9: 929-30(1969).

The results of four rocket measurements of electron concentration during the daytime near the magnetic equator to a height of 200 km were published recently by Aikin and Blumle (J. Geophys. Res., 73: 1617(1968)). An attempt is made to estimate the coefficients of the main ionospheric reactions in the equatorial ionosphere from the data of Aikin and Blumle. (W.D.M.)

30270 FLUCTUATIONS OF THE QUIET IONOSPHERE AT MIDDLE LATITUDES. Khocholava, G. M. (Inst. of Geophysics, Tbilisi, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 749-50(1969).

Translated from Geomagn. Aeron.; 9: 931-2(1969).

Some of the characteristics of the disturbed F2 layer at middle latitudes were investigated on the basis of the results of vertical ionospheric soundings in Moscow during the solar activity minimum (1963–1964). Hourly tables of critical F2-layer frequencies were used for analysis. (W.D.M.)

30271 A METHOD OF STUDYING THE FREQUENCY DEPENDENCE OF ρE_s. Ovezgel'dev, O.; Kelov, K. (Inst. of Terrestrial and Atmospheric Physics, Ashkhabad, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 751-2(1969).

Translated from Geomagn. Aeron.; 9: 933-4(1969).

A special attachment to the AIS ionosonde was developed to study the dependence of the reflection coefficient ρE_s on frequency. This attachment, which makes it possible to obtain simultaneously the h'(f) and amplitude-frequency characteristics, is described. (W.D.M.)

30272 MEASUREMENT OF HORIZONTAL IONOSPHERIC DRIFTS AT TWO NEIGHBORING STATIONS. Zakharov, V. N.; Kazimirovskii, E. S.; Kokourov, V. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 752-3(1969).

Translated from Geomagn. Aeron.; 9: 935(1969).

An experiment on simultaneous measurement of the parameters of the horizontal drift of small-scale inhomogeneities, conducted between June 7 and July 7, 1968, in the vicinity of Irkutsk, is described. (W.D.M.)

30273 METHOD OF CORRECTING THE N(h) PROFILES OF THE F REGION WITH ALLOWANCE FOR A VALLEY. Mal'tseva, O. A. (Rostov State Univ., Rostov-on-Don, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 753-5(1969).

Translated from Geomagn. Aeron.; 9: 936-7(1969).

An examination of the data (Radio Sci., 2: 1119(1967)), devoted to the processing of ground-recorded ionograms, shows that the most complicated and least worked-out problem is that of the computation of electron distribution in the interlayer regions of the ionosphere with $f < f_{max}$ in the underlying layer; i.e., the so-called valley. A method of correction for the vertical F-region profiles is proposed that takes account of the valley ionization by replacing it with an equivalent distribution. (W.D.M.)

30274 CHARACTERISTICS OF FRAGMENTARY FORMATIONS OF BANDLIKE AURORAS. Nadubovich, Yu. A. (Inst. of

Cosmophysical Research and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 755-7(1969).
Translated from Geomagn. Aeron.; 9: 938-9(1969).

To determine the conditions under which fragmentary formations of bandlike aurorae may form, the IGY all-sky films obtained at three stations near the auroral zone (Tixie, Kazach'ye, and Kotel'nyy Island) were analyzed. The measurements were made within zenith distances less than 75°. (W.D.M.)

30275 CONCENTRATIONS OF EXCITED $O_2(^1\Delta g)$ MOLECULES IN THE UPPER ATMOSPHERE. Vlasov, M. N. Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 757-9(1969).
Translated from Geomagn. Aeron.; 9: 940-1(1969).

A system of processes is discussed that may be considered to provide an adequate explanation for both the observed distribution of excited molecules $O_2(^1\Delta g)$ in the upper atmosphere and the integrated luminescence intensity of the infrared emission of oxygen during the day, at night, and at twilight. (W.D.M.)

30276 LATITUDINAL DISTRIBUTION OF THE FIELD OF POLAR MAGNETIC DISTURBANCES AT NIGHT AND IN THE EVENING. Afonina, R. G.; Fel'dshtein, Ya. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 761-2(1969).
Translated from Geomagn. Aeron.; 9: 944-5(1969).

It was felt to be of interest to examine the latitudinal distribution of the field of polar magnetic disturbances in the evening and compare it with that at night. To this end, the longitudinal profiles of stations located at a geomagnetic latitude of ~120° were selected. (W.D.M.)

30277 RELATIONSHIP BETWEEN MAGNETIC DISTURBANCES AND PARTICLE INJECTIONS ON THE NIGHT AND DAY SIDES OF THE POLAR ZONE. Osipov, N. K.; Pivovarova, N. B.; Pivovarov, V. G. (Radio Engineering Inst., Moscow. Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 762-3(1969).
Translated from Geomagn. Aeron.; 9: 946-7(1969).

An analysis of the relationship between magnetic disturbances and the energy of injected fluxes shows that a change in conductivity caused by the interaction of injected fluxes with the atmosphere cannot explain the different magnetic activity of the fluxes during the daytime and at night. It is necessary that the electric field at the E-layer level be proportional to $\sim j_{n0.5}$ during the injection of electron fluxes. (W.D.M.)

30278 GEOMAGNETIC STORM FAMILIES FROM 1957 TO 1964. IV. FAMILIES OF SUDDEN-COMMENCEMENT GEOMAGNETIC STORMS. Afanas'eva, V. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 764-5(1969).
Translated from Geomagn. Aeron.; 9: 947-8(1969).

Families of sudden-commencement geomagnetic storms from Afanas'eva's catalog (IZMIRAN, 1968, Preprint) are discussed and a detailed analysis by the superposition of epochs method is summarized. (W.D.M.)

30279 EQUILIBRIUM CONFIGURATIONS OF A PLASMA IN THE MAGNETIC FIELD OF A TWO-DIMENSIONAL DIPOLE. II. Vo Hong An; Tverskoi, B. A. (Moscow State Univ.). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 641-4(1969).
Translated from Geomagn. Aeron.; 9: 793-7(1969).

A solution is presented of the problem of the equilibrium configurations of a diamagnetic plasma in the magnetic field of a two-dimensional dipole in the case of a discontinuity in the lines of force. The solution is determined for the condition that this "discontinuous" configuration is assumed as the initial state of the plasma. The possibility of applying the results obtained to the problem of the formation of the tail of the Earth's magnetosphere and to the neutral sheet is discussed. (auth)

30280 MOTION OF A PLASMA NEAR THE AXIS OF SYMMETRY INSIDE THE MAGNETOSPHERE. Samokhin, M. V. (Radio Engineering Inst., Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 645-8(1969).
Translated from Geomagn. Aeron.; 9: 798-802(1969).

An approximate solution is found for quasi-hydrodynamic equations describing the motion of a rarefied plasma within the magnetosphere in the equatorial plane of a magnetic dipole near the axis of symmetry. It is shown that there is a frontal point in the magnetosphere; the streamline that crosses this point apparently coincides with the intersection of the plasmapause by the equatorial plane. (auth)

Low-Temperature Physics

Refer also to abstract 30307.

30281 (AD-700439) MAGNETIC AND SUPERCONDUCTING PROPERTIES OF SOLIDS. Final Report. Celli, Vittorio (Virginia Univ., Charlottesville). 5 Jan 1970. 9p. (AFOSR-70-189-TR). CFSTI.

A major group of papers deals with the influence of impurities, magnetic and nonmagnetic, on the properties of superconductors. The effect of magnetic impurities on various properties of normal metals was also calculated. Comparison with experiments should provide further tests of the Kondo model for the impurities. The properties of a superconductor near a boundary with a normal metal were investigated. Detailed explanations of experimental data were obtained through application and refinement of the accepted theory. It was pointed out that proximity effects may also exist in ferroelectric films. Another problem studied in detail is the structure of a negative ion in liquid He. The treatment of the vibrational modes of the ion has been used by others to explain the low temperature mobility. (USGRDR)

30282 (LNF-70/6) TUNNEL EFFECT IN SUPERCONDUCTORS. Note No. 465. Sacchetti, N. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 25 Feb 1970. 41p. Dep. CFSTI (U. S. Sales Only).

The following topics are included: the semiphenomenological theory of the tunnel effect, the general theory of the tunnel effect, higher-order effects, energy-gap anisotropy, photon- and phonon-assisted tunneling, the phonon spectrum as related to the tunnel effect, the decay of quasi particles in a superconductor as related to the tunnel effect, and some applications of the superconducting tunnel effect. (M.H.R.)

30283 (NYO-3699-42) GROUND STATE OF THE INHOMOGENEOUS BOSE LIQUID. Hyman, David Sheldon (Cornell Univ., Ithaca, N. Y. Materials Science Center). Jan 1970. 107p. Dep. CFSTI.
Thesis.

The properties of rotating ideal quantum gases and thin liquid helium films are studied at the absolute zero of temperature. A trial wave function is constructed that describes uniform rigid-body rotation of a large number of noninteracting fermions. This wave function is adapted to treat the corresponding ideal Bose gas, with essentially identical physical results. The energy of the latter system is evaluated exactly, and it is found to be many orders-of-magnitude greater than the energy corresponding to one quantized vortex line of the same total angular momentum. Three different approaches are used to construct a simple model of the ground state of a liquid helium film. The most useful model is studied in detail numerically. This study relies on the use of well-known approximation methods in the theory of classical fluids to perform approximate calculations of the energy from a class of trial wave functions. In the context of these calculations, the model is found to be partially successful in describing thin helium films. The difficulties with the theory, and possible ways to overcome them, are discussed in detail. (auth)

30284 AC FACE FIELD LOSSES IN A TYPE-II SUPERCONDUCTOR. Halse, M. R. (General Electric and English Electric Co. Ltd., Stafford, Eng.). J. Phys., D (London); 3: 717-20(May 1970).

The eddy current distribution in a thin superconducting strip subjected to an ac field perpendicular to its surface is derived for a critical-state model with constant critical current. From this, an approximate expression is obtained for the hysteretic loss per cycle. An approximate expression is also given for a field-dependent critical current. (auth) (UK)

30285 CRITICAL STATE IN HYSTERETIC SUPERCONDUCTORS. Love, G. R. (Oak Ridge National Lab., Tenn.). Phil. Mag.; 21: 1003-26(May 1970).

A model description is proposed for the transport properties of type II superconductors. It proceeds from the general concepts of a critical state resulting from thermally activated motion of current vortices (fluxoids) past barriers (pins) due to forces resembling Lorentz forces. A formal description of the variation in strength of the fluxoid–pin interaction is given as a function of local field and temperature. Expressions are derived that describe the variation in sample critical current density with applied field and temperature and which contain two material parameters, the spacing r_0 and the effectiveness p of pinning sites. Empirical determinations of these parameters, e.g., from the grain size dependence of critical current density, yield plausible values and the values determined in a single experiment (e.g., current density as a function of field) allow successful prediction of the outcome of other experiments (e.g., current density as a function of temperature at constant field). (auth) (UK)

30286 MEASUREMENT OF 50-Hz DISSIPATION IN SUPERCONDUCTING NIOBIUM STRIPS. Grigsby, R.; Slaughter, R. J.

(British Insulated Callender's Cables Ltd., London). J. Phys., D (London); 3: 898-905(Jun 1970).

Measurements of ac losses in superconducting niobium strips by the helium boil-off method were made with a view to assessing the effects of sample thickness, surface finish, and metallurgical hardness on prospective superconducting cable conductor materials. The method of preparing the strip edges was shown to have considerable effect upon the level of measured losses. The measurement technique is described in some detail. (auth) (UK)

30287 PREPARATION AND SUPERCONDUCTING BEHAVIOR OF $CeRu_2$ AND ITS Gd-, Mn-, Fe-, Co-, AND Ni-CONTAINING MIXED PHASES. Wilhelm, M.; Hillenbrand, B. (Siemens AG, Erlangen, Ger.). J. Phys. Chem. Solids; 31: 559-65(Mar 1970). (In German).

Single-phase samples of $CeRu_2$ and homogeneous mixed crystals of the formula $Ce_{1-x}Gd_xRu_2$ and $CeRu_{2-x}Me_x$ (Me = Mn, Fe, Co, Ni) were prepared by means of an appropriate annealing process. Pure $CeRu_2$ becomes superconducting at $T_c = 6.2°K$. In mixed crystals $Ce_{1-x}Gd_xRu_2$, T_c decreases proportional to the fourth power of the $GdRu_2$ concentration. Superconductivity extends up to the amount of about 13 mol. % $GdRu_2$ ($T_c \approx 3.8°K$); alloys exceeding this concentration are ferromagnetic. When adding $CeMe_2$ a linear depression of T_c was observed. The gradient of this depression is about one order of magnitude greater with Me = Fe or Mn than with Me = Co or Ni. Small amounts of iron present in the available cerium metal were removed by zone melting. (auth) (UK)

30288 PROTECTION OF LARGE SUPERCONDUCTING COILS. Bronca, G. (CEN de Saclay, Gif-Sur-Yvette, France); Krikorian, J.; Neel, J.; Vassal, G.; Burnier, P.; Moreau, J. Nucl. Instrum. Methods; 79: 309-14(1970). (In French).

When a quenching occurs in a large coil the dissipation of the energy will increase the temperature of the superconductor and the pressure in the cryostat. The study of these phenomena showed that, using the usual protection device, pressure and temperature can be held at a low value and make the coil safe even if the protection is switched on one second after detection of the quenching. Experimental results obtained on a 10-MJ coil confirm the theory. (auth)

30289 GUIDE TO SUPERCONDUCTIVITY. Fishlock, David (ed.). New York; American Elsevier Publishing Company, Inc. (1969). 157p. $7.00.

Topics included are: the origins of superconduction, high-field superconducting materials, the technology of small magnets, the technology of large magnets, superconductors in motion, superconductors and power transmission, superconducting computer devices, and trends in superconductivity. (M.H.R.)

30290 98- AND 102-kG NIOBIUM–TITANIUM SUPERCONDUCTING MAGNETS. Atherton, David L. (Ferranti-Packard Ltd., Toronto). Can. J. Phys.; 48: 1003-5(15 Apr 1970).

A niobium–titanium compound superconducting magnet is reported, which generates 98 kG in a 1⅛ in. (2.858 cm) bore and 102 kG in a 1 cm bore with an additional niobium–titanium insert. Comments on the design and performance are included together with an introductory summary of the comparative properties of niobium–tin and niobium–titanium superconducting magnets. (auth)

30291 EFFECTS OF EVAPORATED DIELECTRICS ON TRANSITION TEMPERATURES OF SUPERCONDUCTING THIN FILMS. Noda, Minoru; Hanada, Kenji; (and others) (Kyushu Univ., Fukuoka). Kyusnu Daigaku Kogaku Shuho; 42: 642-5(Aug 1969). (In Japanese).

In order to obtain the superconductor with high transition temperature (T_c), after preparing samples being fit for Ginzburg's two-dimensional model, T_c of these samples was measured. The samples were prepared as follows; a glass substrate was covered with Sn in various thicknesses (min. 200 Å), and then coated with some dielectric by vacuum evaporation deposition. Anthraquinone, polyoxymethylene (POM), polyethyleneneterephthalate (PET), polyethylene (PE), and SiO were chosen as the dielectrics, and the relation between polarizability and T_c of these samples was investigated. The film thickness dependence of T_c for pure Sn is shown by an empirical equation, $T_c = T_c(\text{bulk}) + 0.067 + 15.9/d + 2309.7/d^2$, and T_c (bulk) = 3.722°K. In covering Sn-coated samples with the above dielectrics, the increase of T_c was recognized in the order of SiO < PE < PET < POM < anthraquinone. This order agrees with the increasing order of the polarizability of these dielectrics. It is estimated that Ginzburg's mutual interaction exists in the region of several tens Å, thus, if thinner films could be made, a greater effect would be expected. However, even in the amorphous state of a very thin film, the so-called disordered film, the maximum theoretical value of T_c is about 40°K. Actually, it is difficult to realize those samples; therefore, it can be concluded that Ginzburg's model is of no practical use. (NSA of Japan)

30292 CALCULATION OF THE CRITICAL FIELD GRADIENT IN TYPE-II SUPERCONDUCTORS. Labusch, Reiner (Univ., Goettingen, Ger.). Cryst. Lattice Defects; 1: 1-16(Dec 1969).

A statistical theory is developed for calculating the critical flux gradient or the critical current density of type II superconductors from the interaction between a single fluxoid and a single crystalline defect. The interaction of the fluxoids among themselves and their collective behavior is taken into account by treating the fluxoid lattice as an elastic medium. The final result is an expression for the critical gradient in terms of the elastic constants of the fluxoid lattice and of the characteristic parameters of the single fluxoid–single defect interaction. (auth)

30293 ISOTHERMAL FLOW OF LIQUID HELIUM II THROUGH FINE GRAINED POWDER. Schmidt, R.; Keck, K.; Schubert, G. U. (Univ., Mainz). Z. Angew. Phys.; 29: 6-8(23 Apr 1970). (In German).

The investigation of isothermal flow of liquid helium II through various samples of fine-grained powder shows that, by suitable production of the samples, the critical flow rate is the same for all samples. The results can be interpreted under the presumption of a λ shift and the spread of pore sizes. (auth)

30294 NUCLEAR SPIN-LATTICE RELAXATION IN THE MIXED STATE OF SUPERCONDUCTING NIOBIUM. MacLaughlin, D. E.; Rossier, D. (Faculte des Sciences, Orsay, France). Phys. Kondens. Mater.; 11: 43-65(1970).

Pulsed NMR measurements of the spin–lattice relaxation time T_1 were carried out in niobium metal in order to investigate the elementary excitation spectrum in the superconducting mixed state. The dependences of T_1 on temperature, external field, and mean free path were determined. The results below ~5°K were in agreement with the theory of field-induced gapless superconductivity. The best fit was obtained with a scale factor 0.35 ± 0.2, in agreement with recent ultrasonic attenuation results. Anomalously fast relaxation was observed above ~5°K, which could not be interpreted in terms of the present theory of thermal vortex fluctuations. (auth)

30295 MAGNETIC FIELD DISTRIBUTION IN SUPERCONDUCTING NIOBIUM BY NUCLEAR MAGNETIC RESONANCE FOURIER SPECTROSCOPY. Rossier, D.; MacLaughlin, D. E. (Faculte des Sciences, Orsay, France). Phys. Kondens. Mater.; 11: 66-92(1970).

Nuclear magnetic resonance measurements of the superconducting mixed-state field distribution in niobium metal are reported. It is demonstrated that pulsed NMR Fourier spectroscopy (defined in the text) can resolve considerable detail in the field distribution function f(h). A simple analytic model for f(h) was used for numerical calculation of the expected spectrum shape. An ordered vortex lattice was always observed. Far from the transition the spectra were most consistent with triangular lattice symmetry. The temperature variation of the Maki parameter κ_2 was measured. The shift of spectrum position is compatible with appreciable reduction of spin susceptibility in the superconducting state. (auth)

30296 FAR-INFRARED ABSORPTION IN BULK SAMPLES OF SUPERCONDUCTING NIOBIUM AND TANTALUM. Hemming, D.; Sati, R.; Leslie, J. D. (Univ. of Waterloo, Ont.). Can. J. Phys.; 48: 1254-8(15 May 1970).

Measurements have been made of far-infrared absorption in bulk samples of superconducting niobium and tantalum at 1.41°K. The results indicate a gap width 2Δ of 23.8 ± 0.2 cm^{-1} for niobium and 10.3 ± 0.2 cm^{-1} for tantalum. The measured values of the critical temperature, T_c, for these samples are 9.38 ± 0.04°K for niobium and 4.33 ± 0.02°K for tantalum. In terms of these values of T_c, 2Δ is 3.66 ± 0.05 kT_c for niobium and 3.43 ± 0.08 kT_c for tantalum. These values of 2Δ are in good agreement with those obtained by other methods, unlike earlier far-infrared absorption measurements on bulk niobium and tantalum that indicated anomalously low values of 2Δ. (auth)

30297 SUPERCONDUCTING Nb–Ti MICROWAVE CAVITY. Soumpasis, D.; Lueders, K. (Freie Univ., Berlin). J. Appl. Phys.; 41: 2475-6(May 1970).

The properties of a rectangular cavity made of "hard" superconducting $Nb_{0.52}Ti_{0.48}$ alloy and resonating in the TE-101 mode at 9.125 GHz were investigated. Preliminary results in fields up to 10 kG show that such a device could be very useful in applications where high Q's in the presence of strong magnetic fields are desirable. (auth)

30298 ENERGY RELEASED BY FLUX JUMPS IN SUPERCONDUCTORS. Iwasa, Y.; Montgomery, D. B.; Polzer, H. W. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys.; 41: 2476-81(May 1970).

The energy released during a flux jump in single-core Nb–Ti wires and multifilament composite Nb–Ti superconductors was measured. The evaporation of liquid helium produced by the flux jump was indirectly measured and for calibration was compared with that produced by a known energy input generated by a current pulse through a heater wire. The experiment has demonstrated that the equation derived for a slab geometry, relating the magnetization energy to the initial and final value of magnetization, is also valid for the wire samples, and (indirectly) for composite superconductors. For the composite superconductors with nontwisted filaments, the experiment has also shown that the configuration of filaments rather than their number or size is the principle determinant of the magnetization and thus the energy. The experiment further confirms that twisting the filaments along the axis increases the stability of composite superconductors. (auth)

30299 ROTATIONAL HYSTERESIS LOSS IN HIGH-FIELD SUPERCONDUCTORS. Bean, Charles P. (General Electric Research and Development Center, Schenectady, N. Y.). J. Appl. Phys.; 41: 2482-3(May 1970).

The rotational hysteresis loss in hard type-II superconductors is calculated using the critical state model. For materials that can be characterized by a magnetic field-independent critical current density J_c the surface rotational loss is $W(rot)_s = [5/4\pi(6)]^{1/4}(H_0^3/J_c)$ erg/cm^2-cycle. In this expression, H_0 is the amplitude in gauss of a rotating field applied parallel to the surface of a semi-infinite slab while J_c is measured in amperes per square centimeter. This loss is 3.84 times the equivalent loss for alternating fields. In addition, it is shown that by measurement of the hysteresis loss or hysteresis torque as a function of field, one may calculate the field dependence of the critical current. (auth)

30300 TUNNELING SANDWICH STRUCTURES USING SINGLE-CRYSTAL NIOBIUM FILMS. Laibowitz, R. B.; Cuomo, J. J. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys.; 41: 2748-50(May 1970).

The first tunneling measurements using single-crystal niobium films are reported. Also, attempts to use all Nb metallurgy to form the final sandwich structure, which can then be studied at and above 4.2°K, are reported. (M.H.R.)

30301 ELECTRICAL CONDUCTIVITY IN PURE TYPE-II SUPERCONDUCTORS NEAR H_{c2}. Hibler III, W. D.; Cyrot, M. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., B; 1: 3007-16(1 Apr 1970).

The electrical conductivity for a pure type-II superconductor in high magnetic fields near H_{c2} is calculated for frequencies and relaxation times that satisfy the limit $\omega\tau > 1$. The conductivity in the absence of fluctuations, i.e., with a static vortex lattice, is calculated in a manner similar to the procedure used by Brandt, Pesch, and Tewordt to obtain the density of states. This direct approach allows us to bypass an ansatz made by Maki for the purpose of calculating transport properties of pure type-II superconductors. The fluctuations of the order parameter are included in the theory by using the calculation by Caroli and Maki of the conductivity due to fluctuations. In the Pippard limit, the conductivity is calculated numerically. From the conductivity, results for the surface resistance are obtained. The theory predicts that, as the magnetic field is lowered below H_{c2}, a highly frequency-dependent decrease in the surface resistance occurs, especially for frequencies in the neighborhood of 0.5 GHz. This frequency dependence is not present in the surface resistance calculated by Caroli and Maki. For frequencies in the megahertz region, where experimental measurements have been made, the theory predicts a sharper decrease in R_s/R_n than is observed experimentally. It is pointed out, however, that for these frequencies the limit $\omega\tau > 1$ is not valid, and higher-frequency measurements are necessary for direct comparison to the theory. The effects on the surface resistance of a smearing-out of the vortex lattice near H_{c2} are also determined numerically by inserting a phenomenological delocalization factor. (auth)

30302 AMPLIFICATION OF FLUCTUATIONS IN SUPERCONDUCTORS ABOVE T_c. Fulde, Peter (Univ., Frankfurt am Main); Straessler, Sigfrid. Phys. Rev., B; 1: 3017-20(1 Apr 1970).

The contribution of fluctuating Cooper pairs to the electronic spin susceptibility of a superconductor is calculated for temperatures larger than the transition temperature T_c. If paramagnetic impurities are added to the sample, this results in fluctuations in the impurity spin susceptibility. It is shown that through this mechanism, fluctuations in the electronic spin susceptibility are amplified to such an extent that, in the dirty limit, they should become the dominant correction to the total susceptibility. (auth)

30303 CONDENSATION OF THE ROTATING TWO-DIMENSIONAL IDEAL BOSE GAS. Rehr, J. J.; Mermin, N. D. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., B; 1: 3160-2(1 Apr 1970).

The two-dimensional ideal Bose gas in a circular container rotating at fixed rim velocity has some unexpected and instructive properties. In the thermodynamic limit, the system undergoes a phase transition, as argued by Widom. It is found that the transition is a type of Bose–Einstein condensation, in which, however, infinitely many one-particle states are macroscopically occupied. The system evades general theorems forbidding Bose–Einstein condensation in two dimensions, not merely because it is inhomogeneous, as Widom suggests, but because the equilibrium density is unbounded near the circumference in the thermodynamic limit. It is pointed out that, independently of the particular model, Bose–Einstein condensation into any single-particle state (or states), spatially uniform or nonuniform, is forbidden in one and two dimensions provided only that (a) the Hamiltonian is real, and (b) the equilibrium density is everywhere bounded in the thermodynamic limit. (auth)

30304 THEORY AND OPERATION OF PROTON SPIN REFRIGERATORS: SIZABLE PROTON POLARIZATIONS. McColl, J. R.; Jeffries, C. D. (Univ. of California, Berkeley). Contract AT(11-1)-34. Phys. Rev., B; 1: 2917-34(1 Apr 1970). (UCB-34-P-20-139).

The enhancement of proton spin polarization by the spin-refrigerator method, in crystals of $Y(C_2H_5SO_4)_3 \cdot 9\ H_2O$ containing a few percent Yb^{3+}, is studied experimentally and theoretically. The spin refrigerator is operated simply by rotating the crystal in a magnetic field at liquid-helium temperatures, or by subjecting the crystal to a pulsed rotating field. The proton polarization comes about because the Yb spins have both anisotropic g value ($g_{||} = 3.4$, $g_\perp \approx 0$) and relaxation rate ($T_{1e}^{-1} \propto \cos^2\theta \sin^2\theta$), so the Yb spin polarization at $\theta = 45°$ can be transferred by cross-relaxation to the protons at $\theta = 90°$ by rapid rotation of the crystal or field between these two orientations. A unified theory involving electronic and nuclear spin-lattice relaxation, cross-relaxation, and nuclear spin diffusion explains the results of both types of spin refrigerator, and predicts that polarizations as high as 70% may be achieved at higher operating speeds. Proton polarizations as high as 35% are reported, suggesting application to polarized targets. (auth)

Plasma and Thermonuclear Physics

30305 THERMAL CONDUCTIVITY DATA FOR HYDROGEN AND DEUTERIUM IN THE RANGE 100 TO 1100°C. Saxena, S. C.; Saxena, V. K. (Univ. of Illinois, Chicago). J. Phys., A (London); 3: 309-20(May 1970).

The conductivity column method was used to measure the thermal conductivity k of hydrogen, deuterium, and nitrogen from 100°C to 1000, 1100, and 1200°C respectively with an overall uncertainty of ±2%. The data for each gas are correlated by a quadratic polynomial in temperature (T°K). These expressions are: 10^5 k (hydrogen) = $20.37 + 8.20 \times 10^{-2}\ T + 3.56 \times 10^{-6}\ T^2$, 10^5 k (deuterium) = $16.80 + 5.68 \times 10^{-2}\ T + 2.354 \times 10^{-6}\ T^2$, and 10^5 k (nitrogen) = $1.184 + 1.77 \times 10^{-2}\ T - 3.704 \times 10^{-6}\ T^2$. The k values are in cal cm^{-1} sec^{-1} °K^{-1}, and these are in good agreement with the limited data available in the literature as well as with the predictions of theories developed by Hirshfelder (1957), Mason and Monchick (1962), and Saxena (1968), Saksena and Gambhir (1967). This study provides a good support to the column method for the measurement of thermal conductivity. The conductivity data are also used to generate indirectly the viscosity and diffusion coefficients for these gases as a function of temperature. The results are represented in terms of explicit expressions so that the computation at any desired temperature is considerably facilitated. (auth) (UK)

Confinement and Heating

Refer also to abstract 30279.

30306 (IPP-2/81) AN EXPERIMENT ON CYCLOTRON RESONANCE HEATING OF IONS AND ELECTRONS IN A PLASMA. Final Report. Cattanei, G.; England, A. C.; Siller, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug 1969. 12p. Dep. CFSTI (U. S. Sales Only).

Results are described of an experiment in which ions and elec-

trons were to be heated independently at the respective cyclotron resonance frequency. As the experiment was shut down before systematic measurements could be made, the behavior of the plasma could only be qualitatively determined. (auth)

30307 A METHOD FOR TRANSFERRING ENERGY TO A CONDUCTIVE MEDIUM AND AN APPARATUS FOR THE IMPLEMENTATION OF THE METHOD. Sole, Jean (to Commissariat a l'Energie Atomique). British Patent 1,187,150. 8 Apr 1970. Priority date 7 Sep 1966, France.

A method and an apparatus are described for introducing energy into a plasma. The energy is stored in the form of a current flowing through a closed superconductive circuit around the plasma chamber, and its transfer into the plasma is effected by causing the superconductive circuit to undergo transition to the normal state. Several alternative embodiments of the apparatus are described. (See also British Patent 1,187,149). (D.L.C.)

30308 NATURE OF PLASMA LOSSES IN A STELLARATOR. Burchenko, P. Ya.; Vasilenko, B. T.; Volkov, E. D.; Pavlichenko, O. S.; Potapenko, V. A.; Rudakov, V. A.; Tereshchenko, F. F.; Tolok, V. T. At. Energ. (USSR); 28: 126-9(Feb 1970). (In Russian).

Equilibrium conditions and low-frequency oscillation spectra of plasma produced by ohmic heating in a stellarator were investigated. It was shown that the equilibrium is broken with $\beta = (nkT \cdot 8\pi/H_0^2)$ exceeding some critical value β_e. As a result of investigation, with $\beta < \beta_e$ of low-frequency oscillations that are of great importance for the diffusion, one can come to a conclusion that drift instabilities (drift-dissipative or thermoforce modes) appear in collisional plasma in the stellarator. (auth)

30309 STOCHASTIC HEATING OF AN ELECTRON PLASMA IN A MAGNETIC MIRROR FIELD. Namba, C.; Kawamura, T. (Nagoya Univ., Japan). Phys. Lett.; 31A: 555-6(18 May 1970).

The heating of an electron plasma in a magnetic mirror is considered by numerically tracking electron orbits. It is demonstrated that the presence of a stochastic mechanism leads to heating. (auth)

30310 PLASMA CONVECTION IN A TOROIDAL OCTUPOLE. Schmidt, J. A. (Univ. of Wisconsin, Madison). Phys. Rev. Lett.; 24: 721-4(30 Mar 1970).

Spatial variations of floating potential and density are reported for a toroidal octupole. Large-scale convective structures are observed. A definite correlation is observed between known magnetic perturbations and the density-potential structures, as well as between these structures and the azimuthal variations in plasma loss. (auth)

Diagnostics

30311 (AD-687181) BEAM PROBE MAPPING OF RAPIDLY FLUCTUATING PLASMA DENSITY IN AN ENERGETIC ARC. Report No. 4 (Final), December 1, 1967-November 30, 1968. Hickok, R. L.; Jobes, F. C.; Marshall, J. F. (Mobil Research and Development Corp., Princeton, N. J. Central Research Div. Lab.). Jan 1969. Contract F44620-67-C-0043. 89p. (AFOSR-69-644-TR). CFSTI.

The rapidly fluctuating density in an energetic arc plasma was mapped with good spatial and temporal resolution by probing the plasma with an energetic H_3^+ molecular ion beam. The H^+ atomic ion current produced by collisional dissociation of the H_3^+ ions was sampled in synchronization with a coherent oscillation in the arc plasma to produce stroboscopic maps at six different phases. Both the total density of the arc and the density perturbation of the oscillation, which was an $m = 1$ azimuthal wave propagating about an off-center axis, were measured. Conventional assumptions, such as cylindrical symmetry and the concentricity of the density and the density perturbation, which are widely used to interpret less-detailed measurements, are shown to be invalid for this helium arc and are probably invalid for similar systems. Three generalizations of the beam-probing technique are also discussed: (1) a low-energy heavy ion beam for probing both plasma density and space potential; (2) a fast multichannel recording and data-handling system for making real-time maps; and (3) the density distribution in the outlet of a neutral gas jet. (auth) (USGRDR)

30312 (AD-691905) MICROWAVE STUDIES OF IONIZATION PHENOMENA IN GASEOUS DISCHARGES. Final Scientific Report, January 1, 1967-February 28, 1969. Sexton, Michael C. (University Coll., Cork (Ireland). Dept. of Electrical Engineering). 1 Apr 1969. 11p. (AFOSR-69-2005-TR). CFSTI.

Microwave and spectroscopic analyses of high-density pulsed afterglows in argon, helium, and hydrogen were carried out. Results in the rare gases supported the theoretical prediction of collisional-radiative recombination as a major electron removal process, especially at high densities, and were particularly interesting in argon as little detailed information was previously available in this gas. The atomic-to-molecular ion-conversion mechanism was also studied in argon. The possibility of negative ion formation in hydrogen was examined at low pressure, whereas at pressures above 1 torr the existence of complex molecular hydrogen ions was inferred. The locations of the Tonks-Dattner resonances in current-modulated cylindrical plasma (positive columns) using microwave absorption were shown to depend on whether the increasing or decreasing half-cycle was under observation. A similar effect was noted when the more fundamental parameter, electron density, measured with a microwave cavity, was used to monitor the resonant spectra. (auth) (USGRDR)

30313 (IPP-3/103) PROBE MEASUREMENTS OF THE RADIAL DISTRIBUTIONS OF POTENTIAL, ELECTRIC FIELD, AND CURRENT DENSITY IN A HYDROGEN ARC WITH AN AXIAL MAGNETIC FIELD. Schwenn, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Dec 1969. 41p. (In German). Dep. CFSTI (U. S. Sales Only).

The radial distributions of potential, electric field, and electric current density in a stationary hydrogen arc with axial magnetic field were measured. This was done by shooting various potential probes or induction-coil probes across the arc. A temperature profile in good agreement with those of other experimental methods was derived from current-density and field-strength measurements. The experiments showed that outside the magnetic flux tube defined by the cathode radius the axial electric field strength E_z strongly decreases and tends to zero. This confirms the theory predicting that the radius of an arc in an axial magnetic field is essentially governed by the electrodes and not by the wall radius of the discharge vessel. Rotation of the arc also has a strong influence on the distribution of E_z. This was particularly obvious in a fast rotating arc with hollow anode. Here E_z almost vanishes even on the axis and attains its maximum at about the radius of the cathode. This results in a distinctly tube-like current density distribution, which was measured directly with the coil probes. From the measurements of electric current density and field strength it is possible to determine the ohmic heat input to the arc. This is much larger than the energy that can be lost radially as a result of thermal conduction according to the measured temperature profile and the thermal conductivity known from theory. Radial mass flow directed outwards may be the cause. Allowing in the calculations for even relatively slow flows ($v_r < 10^4$ cm/sec) yields good agreement with the measured distributions. (auth)

30314 (MATT-Trans-101) METHOD FOR MEASURING MAGNETIC SURFACES USING A DIELECTRIC GRID. Popryadukhin, A. P. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated for Princeton Univ., N. J., from Preprint No. 108. 14p. Dep. CFSTI.

The development of a fast method of recording surfaces also permits one to consider the problem of compensation for the most dangerous resonance perturbations of the field since it becomes possible operatively to control the shape of the surfaces after each change in amplitude and phase of the compensating harmonic of the magnetic field. (M.O.W.)

30315 (N-70-21713) MEASUREMENT OF THE COHERENT OSCILLATIONS AND TURBULENCE IN PLASMA USING RESISTIVELY AND CAPACITIVELY COUPLED PROBES. Serafini, John S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1970. 20p. (NASA-TM-X-1975; E-5466). CFSTI.

Low-frequency coherent oscillations and turbulence in plasmas were studied in a crossed field plasma source (axial electric and radial magnetic fields) with a slightly ionized, low-current, low-pressure argon discharge. Spectra obtained with both types of probes contain a peak indicative of the coherent oscillation and are otherwise generally similar. Correlations of the potential fluctuations sensed by capacitively coupled probes with the density fluctuations sensed with a resistively coupled probe indicate strong correlations near the frequency of the coherent oscillation. The use of two capacitively coupled probes in a differential mode permits deductions concerning the temporal and spatial scales of the turbulence. Such information prescribes necessary conditions if electric fields are to be directly measured. (auth) (STAR)

30316 CALCULATION OF PLASMA TRANSPARENCY BASED ON INTERFERENCE-PATTERN CONTRAST. Babin, L. V.; Plis, A. I. Opt. Spectrosc. (USSR)(Engl. Transl.); 26: 562-3(Jun 1969).

Translated from Opt. Spektrosk.; 26: 1037-40(Jun 1969).

The change of contrast of the interference in the two beams in an interferometer is calculated; applications in plasma diagnostics are discussed. (M.O.W.)

30317 REFINEMENTS IN THE HELIUM LINE RATIO TECHNIQUE FOR ELECTRON TEMPERATURE MEASUREMENT AND ITS APPLICATION TO THE PRECURSOR. Latimer, I. D.; Mills, J. I.; Day, R. A. (Univ. of Oklahoma, Norman). J. Quant. Spectrosc. Radiative Transfer; 10: 629-35(Jun 1970).

A study of the use of spectral intensity ratios as electron temperature indicators was made, identifying crucial factors for accurate use. In application to the photopreionization component of electric shock tube precursor luminosity, certain unexpected results are reported that show the effectiveness of this revised tool. (auth) (UK)

30318 SPECTRAL WIDTH OF PLASMA OSCILLATIONS. Kojima, Shoji; Itakura, Akiyoshi; Nakamura, Yoshiharu (Tokyo Univ. of Education). J. Phys. Soc. Jap.; 28: 1565-70(Jun 1970).

The width of electron plasma oscillations is measured with a spectrum analyzer. An autocorrelation function of the oscillation is also measured with a standing-wave detector and delay lines. The measured oscillations are set up as a standing wave between electrodes in a low-pressure discharge tube. By changing discharge parameters, several modes of standing wave are observed. In the middle of each mode the oscillation is strongest and its width is narrowest, being smaller than the collision frequency. The measured autocorrelation function is of an exponential type that gives a Lorentzian spectrum. The width of it accords with that observed by the spectrum analyzer. When a low-frequency oscillation is present spontaneously or artificially, the line shape of plasma oscillation displayed on the spectrum analyzer seems to be broad, but the time resolved one is sharp. (auth)

30319 MEASUREMENT OF MAGNETOPLASMA BY CIRCULARLY POLARIZED MICROWAVE. Minami, Kazuo (Nagoya Univ., Japan). Kakuyugo Kenkyu; 24: No. 3, 151-62(Dec 1969). (In Japanese).

The measurement of magnetoplasma was performed, using circularly polarized microwaves. Decaying plasma was produced in a coaxial discharge tube 130 mm in length and 26 mm in diameter filled with 0.1-mm-Hg argon gas. A longitudinal magnetic field up to 5 kG was applied by a condenser discharge. Microwave frequency used was 9355 MHz. The reflection of microwaves from the plasma was measured with a pair of microwave probes. The standing wave of microwaves moved inwardly as the plasma decayed, and the movement was less for right-hand than for left-hand circularly polarized waves. The anomalous skin effect was insufficient to explain the difference. The boundary condition adopted in the calculation is discussed in connection with this discrepancy. (NSA of Japan)

30320 ELECTROSTATIC PROBE AND ELECTRONIC CIRCUIT FOR LOW-TEMPERATURE PLASMA MEASUREMENTS. Musal, Henry M. Jr. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). J. Appl. Phys.; 41: 2605-9(May 1970).

The principles of operation and practical realization of a planar guard-ring probe with a floating potential electrode, and an associated electronic circuit to accomplish floating potential compensation of the probe characteristic, are described here. This configuration provides stable and reproducible measurement of the complete planar Langmuir probe characteristic in low-electron-temperature plasma, even in the presence of spurious potential fluctuations. (auth)

30321 MEASUREMENTS OF ION TEMPERATURE IN TOKAMAK-3 DEVICE BY DOPPLER BROADENING OF DEUTERIUM AND HYDROGEN LINES. Mirnov, S. V.; Semenov, I. B. At. Energ. (USSR); 28: 129-31(Feb 1970). (In Russian).

Measurements are presented of the ion temperature by a modification of the usual optical method of determining the ion temperature by Doppler broadening. The modification to this method consists of injecting rapidly into the deuterium plasma a flux of hydrogen atoms to enable optical observation of the neutral atoms possessing the ion temperature. The average ion temperature across the plasma column was obtained. The values are in the region of 70 to 150 eV and compare well with the results of measurements of the ion temperature for the spectral analysis of neutral discharge atoms. (auth)

30322 RADIAL DENSITY DISTRIBUTION IN THE POSITIVE COLUMN IN A MAGNETIC FIELD. Maruyama, Takeo; Hirasawa, Saburo; Imazu, Shingo (Niigata Univ., Nagaoka, Japan). Niigata Daigaku Kogakubu Kenkyu Hokoku; No. 19, 43-50(Mar 1970). (In Japanese).

In 1958, Lehnert reported on the existence of an anomalous diffusion phenomenon in the longitudinal magnetized plasma. Then, in 1960, Kadomtsev and Nedospasov showed theoretically that a helical instability occurs near the critical magnetic field B_c, assuming that the perturbed densities of electrons and ions equal each other and are small, respectively. Recently, Imazu et al., and Itoh et al., pointed out experimentally that it is inappropriate to deal with the helical parts of this instability by linear approximation. Then Holter and Johnson calculated the radial density by assuming that there is a finite-amplitude helix in the plasma in addition to a stationary-background plasma. But, in this case, they assumed that the perturbed densities of electrons and ions equal each other. The effect of helical instability on the radial density distribution in the magnetized plasma is investigated theoretically, under the assumptions that the densities of electrons and ions are perturbed independently and that the perturbed densities have the finite amplitudes. Under those restrictions, an equation of steady-state densities in the radial distribution is derived readily by applying the integral equation of Volterra type. It is also reported that the obtained equation is simple and practically applicable. This dependence is in good agreement with experimental results. (auth)

30323 MICROWAVE METHOD FOR THE MEASUREMENT OF THE RELATIVE PHASE AND RELATIVE AMPLITUDE OF THE VARIATIONS OF THE ELECTRON DENSITY AND COLLISION FREQUENCY IN A PLASMA. Sicha, M.; Drouet, M. G.; Gervais, C.; Glaude, M. V. (Univ. of Montreal). Czech. J. Phys.; 20: 684-93(1970).

A microwave diagnostic method is developed to study the amplitude variations of electron density and collision frequency and the phase difference between these two variables in a weakly ionized gaseous plasma. The method is utilized to study the perturbations of a nitrogen positive column through which an acoustic wave is propagating. (auth)

30324 DIAGNOSTICS OF TIME-DEPENDENT PLASMA BY MEANS OF ELECTRIC PROBES. Zakrzewski, Zenon. Postepy Fiz.; 21: 247-67(1970). (In Polish).

The field of application of the electric probe to plasma diagnostics is still growing. The principles and possibilities of using probes in the presence of fast changes of plasma parameters, and in the presence of a moderate magnetic field, are presented. The methods of measurement of the instantaneous values of the plasma density, space potential, and electron temperature are discussed. The time and space resolution of these methods are estimated. The influence of plasma oscillations on the long-time average probe characteristic is considered. The correspondence between the shape of this characteristic and the mean plasma parameters is pointed out. (auth)

Kinetics (General)

30325 (IPP-3/101) TABLES FOR PRESSURE INCREASE AND THERMAL CONDUCTIVITY IN A CYLINDRICALLY SYMMETRIC HYDROGEN PLASMA IN AN AXIAL MAGNETIC FIELD TAKING INTO ACCOUNT THERMAL FORCES. Raeder, J.; Wirtz, S. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct 1969. 252p. (In German). Dep. CFSTI (U. S. Sales Only).

The pressure increase and thermal conductivity normal to the magnetic field are calculated for a cylindrically symmetric hydrogen plasma column in an axial magnetic field. The calculation, based on the first and third moments of the Boltzmann equations for atoms, ions, and electrons, are carried out by using both the Saha and the Korona equations. Numerical results are tabulated for magnetic fields ranging from 1 to 10 tesla, external pressures ranging from 1 to 10^4 N/m^2 and temperatures ranging from 6×10^3 to 10^6 °K. (auth)

30326 SEMICONDUCTOR PLASMA INSTABILITIES: INCLUDING GUNN EFFECT AND AVALANCHE OSCILLATIONS. Hartnagel, Hans. New York; American Elsevier Publishing Company, Inc. (1969). 223p. $11.00.

The following chapters are included: (1) semiconductor physics, (2) relevant equations for plasma instabilities, (3) methods for the analysis of instabilities, (4) instabilities of semiconductor plasmas, and (5) devices. (M.O.W.)

30327 EXPERIMENTS USING A 25-kw HOLLOW-CATHODE LITHIUM VAPOR MPD ARCJET. Fradkin, D. B.; Blackstock, A. W.; Roehling, D. J.; Stratton, T. F.; Williams, M.; Liewer, K. W. (Los Alamos Scientific Lab., N. Mex.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 886-94(May 1970).

The performance is reported of a 25-kW, lithium-fueled, applied-field MPD arcjet that incorporates a unique feed system with an "open-ended heat-pipe" vaporizer and a hollow cathode. The arc typically operates at currents of 250 to 500 A, voltages

of 40 to 60 V, magnetic field strengths between 500 and 3,000 G, and produces a highly ionized lithium beam that transports 70% of the input electrical power to the beam stop. The ambient tank pressures range as low as 2×10^{-7} torr. A comparison of hollow-cathode and conventional MPD arc performance is made and it is concluded that the hollow-cathode arc is superior to the conventional design. Diagnostic experiments performed in the exhaust plume include the determination of axial ion and atom velocities by measurements of Doppler shifts with a scanning Fabry–Perot interferometer and of ion energies by use of electrostatic energy analyzers; the determination of ion temperatures by comparison of experimental and calculated spectral line profiles; the determination of electron temperatures and densities with electrostatic probes; and the determination of current densities by Rogowski loops. These measurements indicate that at a station 25 cm downstream of the arc head the directed ion velocity exceeds 2×10^6 cm/sec. At a station 90 cm downstream the plasma typically has an electron temperature of about 2.3 eV, a density of approximately 1.5×10^{12} cm^{-3}, and under certain operating conditions more than 40% of the arc current extends 90-cm downstream of the arc head. The efficiency of a process that converts input electrical power into kinetic energy is discussed in terms of a model that sets the plasma into rotation with subsequent expansion in a magnetic field. (auth)

Kinetics (Experimental)

Refer also to abstract 30149.

30328 (AD–702077) INVESTIGATIONS OF IONIC SPECIES IN HIGH-PRESSURE CESIUM DISCHARGES. Annual Report No. 4, March 1, 1969–February 28, 1970. Chanin, L. M. (Minnesota Univ., Minneapolis. Inst. of Tech.). 28 Feb 1970. Contract N00014-67-A-0113-002. 32p. CFSTI.

Ionic sampling studies were performed on cesium plasmas using dc as well as rf excitation. For dc discharges sampling was undertaken through both the anode and cathode. Measurements were made for normalized pressures from 0.0001 to 0.1 torr. The major ions observed were Cs^+, Cs_2^+ and Cs_3^+. For a fixed cesium pressure, I (Cs_2^+/Cs^+) and I (Cs_3^+/Cs^+) in general, decreased with increasing values of the total ion signal. At low pressure, about 0.0001 torr, Cs^+ was dominant, however about 0.1 torr the ion signals of Cs_2^+ were comparable to those of Cs^+. The ion current signals of Cs_3^+ increase rapidly with cesium pressure. (auth) (USGRDR)

30329 (SIT–2813–49) ANNUAL PROGRESS REPORT, FEBRUARY 1969–JANUARY 1970. Rogers, Kenneth C.; Motz, Robin O. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Feb 1970. Contract AT(30-1)-2813. 25p. (SIT–247). Dep. CFSTI.

Research during the previous twelve months (February 1969–January 1970) is described. This work is a continuation of the studies initiated in 1964 of a low beta, magnetically confined, quiescent plasma column (Q-plasma). The work consisted of the following: (a) optical measurement of barium ion density, (b) initiation of optical measurement of electron and ion temperature, (c) design of field coils to oscillate the plasma column adiabatically, (d) partial calculation of the cross-section for collisional excitation of the barium ion from the ground state by electron impact, (e) modification of the electrode structure to utilize the full power of the new plate power supply, and (f) design and construction of probe driving mechanism and on-line probe readout for computer analysis. (M.O.W.)

30330 INTERACTION OF CHARGED-PARTICLE STREAMS WITH PLASMAS. Yamamoto, Takayoshi (Osaka Univ.). Mem. Inst. Sci. Ind. Res. Osaka Univ.; No. 27, 135-92(Mar 1970).

An electron beam is injected into diffused hydrogen plasmas parallel to the magnetic field and the nonlinear phenomena of the convective instability are observed. Furthermore, the parameter space inherent in the beam–plasma regime is divided into two regions, one being the coherent domain where the excited wave keeps its coherence and the other the incoherent one where the wave loses its coherence and the regime becomes turbulent. On the other hand, injection of the electron beam into the plasma perpendicular to the external magnetic field causes excitation of the ion-cyclotron harmonic waves, a kind of absolute instability, which suggests the possibility of the energy transfer between the electron beam and the plasma ions. The ion cyclotron harmonic waves are also excited in the HX Device (High-energy molecular-ion injection-type mirror device), where the obliquely injected molecular-ion beam takes a helical path in the cold plasma generated secondarily in the magnetic mirror, and radiations are observed near integral multiples of the ion-cyclotron frequencies. The parameter dependences of the radiation intensity are well interpreted with the results obtained in case of the perpendicular injection of the electron beam. Those radiations are undesirable from a viewpoint of fusion, and suppressing the radiation with reference to the experiments performed with the electron beam is discussed. (auth)

30331 EXCITATION OF THE BERNSTEIN MODE DUE TO THE HELICAL ELECTRON BEAM IN PLASMA. Idehara, T.; Ishida, Y. (Fukui Univ., Japan). Phys. Lett.; 31A: 568-9 (18 May 1970).

It is shown experimentally that the excitation of the Bernstein mode is due to the velocity component of the electron beam perpendicular to the magnetic field $v_{0\perp}$. (auth)

30332 CURRENT PATTERN AND GAS FLOW STABILIZATION IN PULSED PLASMA ACCELERATORS. Eckbreth, Alan C. (United Aircraft Research Labs., East Hartford, Conn.); Jahn, Robert G. AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 138-43(Jan 1970).

Current sheets propagating in a parallel-plate accelerator are found to arrest their motion at an electrode/insulator junction, and there to lapse into stable, quasi-steady discharges. Kerr-cell photography, magnetic and electric probing, and terminal-voltage measurements indicate that these stabilized discharges accelerate gas through themselves as long as gas from the prefilling of the discharge chamber is available, after which enhanced erosion of insulator and electrode material appears. To supply fresh gas to the stabilized current zone with a minimum of delay, a shock-tube gas injection technique is used. Even with this procedure, it is found that the current must be driven for hundreds of microseconds before a quasi-steady gas flow can be established in contrast to the tens of microseconds required for electrodynamic stabilization. This quasi-steady flow mode, characterized by both current pattern and gas flow stabilization again is observed to provide substantial acceleration of the inlet flow. (auth)

30333 DOPPLER-SHIFT MEASUREMENTS OF AXIAL AND ROTATIONAL VELOCITIES IN AN MPD ARC. Kogelschatz, Ulrich (Langley Research Center, Hampton, Va.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 150-4(Jan 1970).

An MPD are using a bariated-tungsten cathode with NH_3 as a propellant was studied (current: 100 to 700 A; magnetic field: 600 to 5,000 G; mass flow: 10 and 17.5 mg/sec). A 3.4-m spectrograph (Ebert mounting) was used. Reference lines from an iron arc were used rather than from a side-on view of the plasma beam itself. The shifts were obtained from microdensitometer traces of photographic plates. All ion lines are noticeably slanted with respect to the reference lines indicating strong rotation of the plasma beam. Rotational and axial velocities of nitrogen ions were obtained at different axial positions. Neutral species (nitrogen, hydrogen) show much smaller axial velocities and no rotation. Clear evidence of ion acceleration in the magnetic nozzle downstream of the electrode gap could be established. (auth)

Kinetics (Theoretical)

Refer also to abstract 30422.

30334 (AD–685806) QUANTUM MECHANICAL STUDY OF PLASMAS. Final Scientific Report. Ashby, Neil; Holzman, Melvyn; Boulanger, Phillipe (P. E. C. Research Associates, Inc., Louisville, Colo.). Dec 1968. Contract AF33(615)-1652. 180p. (ARL–68–203). CFSTI.

The report consists of three independent chapters. Each chapter gives the results of investigation into one area of the problem of quantum effects in many-particle systems. Chapter I reports the discovery of a method of exact solution of a class of Schroedinger equations that describe the response of a spin system to an oscillating magnetic field. Chapter II reports the progress made towards the development of an improved statistical model for electrons in heavy atoms. Chapter III is concerned with boundary effects such as the interaction of longitudinal and transverse waves at a sharp boundary in an electron gas, such as occurs at a metallic surface or density discontinuity in a hot plasma. (auth) (USGRDR)

30335 (AD–692744) INVESTIGATION OF THE DYNAMICS OF IONIZED MEDIA (PLASMAS). PARTS I AND II. Brittin, Wesley E.; Chappel, Willard R. (P. E. C. Research Associates, Inc., Louisville, Colo.). Apr 1969. Contract AF33(615)-2705. 76p. (ARL–69–68). CFSTI.

A statistical mechanical theory of fields is developed. Since a field has an infinite number of degrees of freedom, it is natural and convenient to use functional methods for its description. The most general statistical mechanical state for a field is represented by a distribution functional that satisfies a functional differential equation analogous to the Liouville equation. The functional

Fourier transform (characteristic functional) is introduced and its properties are studied. Multitime functionals and various reduced distribution functions are also discussed. The formalism is applied to the free electromagnetic fields as well as to a system of charged particles (plasma) interacting via the electromagnetic field. (auth) (USGRDR)

30336 (AD-702406) ON ANNIHILATION AND OTHER INTERACTIONS OF POSITRONS IN A PLASMA. Final Technical Report (Part 2). Wolfer, Wilhelm G.; Schneider, Richard T. (Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences). 1 Jan 1970. Contract Nonr-580(19). 140p. CFSTI.

A consistent derivation of the nonrelativistic Hamiltonian for a many-body electron–positron system is given, as well as a general formula for the annihilation probability in such a system. The derivations begin with the proper relativistic expressions and are based on a power expansion of the electron–positron field operators in terms of (k/K), where hk is the nonrelativistic momentum of the particles and K the inverse of the electron Compton wavelength. The theory is carried out up to the second power in (k/K) for the Hamiltonian as well as the annihilation probability. An upper momentum cutoff k (max) = K is introduced to avoid divergences and ensure the convergence of the expansion. The annihilation rate and the angular correlation function are then evaluated for a plasma as a function of the electron temperature, assuming thermal equilibrium for electrons as well as positrons. Finally, a short survey of processes other than annihilation with free electrons is given. (auth) (USGRDR)

30337 (EUR-CEA-FC-534) INSTANTANEOUS POPULATION DENSITIES OF THE EXCITED LEVELS OF HYDROGEN ATOMS, HYDROGEN-LIKE IONS, AND HELIUM ATOMS IN OPTICALLY THIN AND THICK NON-L.T.E. PLASMAS. Drawin, H. W.; Emard, F. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1970. 233p. Dep. CFSTI (U. S. Sales Only).

The instantaneous population densities were calculated for the levels of atomic hydrogen, hydrogen-like ions, and atomic helium on the basis of the collisional–radiative model. The calculations were performed for the optically thin case as well as for four different degrees of radiative absorption characterized by the gross radiative reduction coefficients Λ_{ij}, Λ_i. The results are listed in tables containing two dimensionless coefficients $r_i^{(0)}$ and $r_i^{(1)}$, from which the absolute values of the instantaneous population densities can be calculated if the actual number density of the ground state particles is known. For a completely homogeneous, steady-state plasma these population densities were calculated. The results are listed in separate tables. It was assumed that the particles have a Maxwellian distribution. However, the results can also be used for determining the population densities in plasmas containing two distinct groups of electrons of very different density and temperature. The results are discussed. Attention is drawn to the possibility of establishing a pseudo-LTE distribution among the levels when the system is neither in the collision nor in the radiation-dominated regime. Such a regime is realized when the electron density and temperature gradients are so high that the (electronic) ambipolar diffusion time (for traversing a boundary layer) is shorter than the time for establishing a quasi-equilibrium distribution among all levels. The present results are well suited to treat this case quantitatively. The numerical values given in this paper are also applicable to the opposite case where the plasma state is governed by neutral particle diffusion rather than by ambipolar diffusion. The calculations also show that, in the case of a stationary homogeneous plasma with complete optically opaque resonance lines, the equilibrium populations for complete LTE are not established when the electron density is lower than approximately 1×10^{16} cm^{-3} for atomic hydrogen, $Z^7 10^{16}$ cm^{-3} for hydrogen-like ions, and 10^{17} cm^{-3} for atomic helium, provided the temperatures are higher than approximately $Z^2 10^4$ °K. (France)

30338 (N-70-19813) SIMULATION OF THE FOKKER–PLANCK EQUATION BY RANDOM WALKS OF TEST PARTICLES IN VELOCITY SPACE WITH APPLICATION TO MAGNETIC MIRROR SYSTEMS. Englert, Gerald W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb 1970. 77p. (NASA-TN-D-5671; E-5165). CFSTI.

The structure of an analytical expression obtained from a random-walk process was compared with that of the Fokker–Planck equation. The step sizes and probabilities of taking steps in various directions were related to the coefficients of the Fokker–Planck equation. Spherical coordinates with azimuthal symmetry about the polar axis were used. The technique was applied to a magnetic-mirror system for confining charged particles. The cases selected have approximate analytical solutions via the Fokker–Planck equation. Velocity distributions inside and end losses from this system were determined by the random-walk procedure and compared with results of the analytical solutions. (auth) (STAR)

30339 (N-70-21710) INDUCED PRESSURE AND TEMPERATURE GRADIENTS IN A PLASMA AS A RESULT OF WEAK ELECTRIC FIELDS. Meador, William E. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Mar 1970. 22p. (NASA-TN-D-5723; L-6877). CFSTI.

Computations are presented in the induced pressure and temperature gradients resulting from the application of weak electric fields to plasmas. Two methods are employed to solve an approximate model of the corresponding electron Boltzmann equation: (1) the direct approach consisting of an exact solution through quadratic terms in the electric field, and (2) Everett's technique for closing out the macroscopic equations of change with Grad's 13-moment velocity distribution function. Comparisons between the two sets of results indicate substantial differences for most interparticle interaction potentials, especially with regard to the induced temperature gradient; hence, the Grad 13-moment approximation may not accurately describe some of the fundamental aspects of plasma transport phenomena. (auth) (STAR)

30340 ELECTRODYNAMICS AND STATISTICAL MECHANICS OF LINEAR PLASMA RESPONSE FUNCTIONS. Golden, K. I.; Kalman, G. (Brandeis Univ., Waltham, Mass.). J. Statist. Phys.; 1: 415-66(1969).

The Kramers–Kronig relations, sum rules, and symmetry properties for the electrodynamic transport tensors of a linear plasma medium are discussed. For complete generality, both nonrelativistic and relativistic plasmas with and without external magnetic fields are considered. The study is carried out first within the framework of classical electrodynamics. Then the statistical-mechanical fluctuation–dissipation theorem was used to further obtain the Onsager symmetry relations and Kubo sum-rule frequency moments. Of special significance is the emergence of a variety of new Kramers–Kronig formulas and f-sum rules for the inverse dispersion tensor. (auth)

30341 INTERACTION OF TEST WAVES AND TRAPPED PARTICLES IN A COLLISIONLESS ELECTRON PLASMA. Yagishita, Takashi; Ichikawa, Yoshi H. (Nihon Univ., Tokyo). J. Phys. Soc. Jap.; 28: 1559-65(Jun 1970).

Theoretical studies are undertaken for effects of the interaction between test waves and trapped particles in the presence of a large-amplitude monochromatic plasma wave of field amplitude E_0 and wave number k_0. It is found that the oscillatory variation of the spatial average of the velocity distribution function due to electrons trapped in the wave troughs gives rise to an additional contribution to the plasma polarizability. Furthermore, the trapped electrons induce instabilities of side bands at frequencies $\omega_k \pm \omega_B$, where ω_k is the frequency of a test wave having wave number k and $\omega_B = (\sqrt{2}\, eE_0k_0/m)^{1/2}$ is the bounce frequency of electrons of charge -e and mass m in the wave troughs of the large-amplitude plasma wave. (auth)

30342 CLASSICAL SELF-CORRELATION FUNCTIONS IN NONCOLLISIONAL PLASMAS IN A MAGNETIC FIELD. Weil, J. W. (Univ. of Innsbruck). Acta Phys. Pol.; A37: 471-3(Mar 1970).

The classical two-particle self-correlation function as introduced by Van Hove and Sunakawa is derived for a plasma immersed in a magnetic field; collisions are neglected. It is discussed for $\omega t \ll 1$ and $\omega t = (\pi/2)$ and its relation to scattering problems is stressed. (auth)

30343 EIGENVALUES OF MICROWAVE CAVITY FILLED WITH PLASMA OF VARIABLE RADIAL DENSITY. Shohet, J. L.; Hatch, Albert J. (Argonne National Lab., Ill.). J. Appl. Phys.; 41: 2610-18(May 1970).

A solution to the eigenvalue problem of a cylindrical plasma of variable radial density placed coaxially within a cylindrical cavity was obtained. The solution is based on a model constructed by dividing the plasma into a series of concentric shells, in each of which the plasma density is assumed to be constant but not necessarily equal to that of any other shell. Maxwell's equations are solved exactly for the electromagnetic fields in each shell. The boundary relations at the inner and outer surface of each shell and at the cavity walls result in a set of simultaneous equations that may be solved numerically for the eigenfrequencies if the cavity dimensions, number of shells, and density in each shell are specified. For a given density profile, which may be obtained from experiments, the frequency shift of the system for a given mode may be determined as a function of the density of the central shell. A 10-shell model was used to solve for the frequencies of the first 10 modes of a cylindrical cavity. (auth)

30344 CHARACTERISTICS OF RADIATION-DOMINATED ELECTRIC ARCS. Lowke, J. J. (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys.; 41: 2588-2600(May 1970).

Temperature profiles of arcs when radiation is the principal energy transfer process were derived from material functions. Arcs that are optically thin are approximately isothermal or constricted depending on whether ϵ_N/σ is an increasing or decreasing function of temperature; ϵ_N is the net emission coefficient and σ the electrical conductivity. Arcs that are optically thick have a temperature profile similar to conduction-dominated arcs. Theoretically predicted examples of these three types of arcs are a 2000-A arc at 30 atm in air, a low current arc in the vapor of a rare-earth metal at 20 Torr, and a 4000-A arc at 1000 atm in air. For arcs which are nearly isothermal, it is possible at any value of current and radius to make approximate calculations of (1) the temperature of the arc core, (2) the electric field strength, (3) the thickness of the outer arc sheath, and (4) the fraction of the input energy carried to the wall by conduction. Such calculations are made for arcs in air and are compared with the results of exact calculations which take into account the details of the self-absorption of radiation. Approximate calculations show that when ϵ_N/σ has a maximum as a function of temperature, multiple solutions for the temperature profile are possible for some values of arc current and radius. (auth)

30345 POLARIZATION OF THE PLASMA CLUSTER DURING ACCELERATION. Kracik, J.; Maloch, J. (Technical Univ., Prague). Czech. J. Phys.; 20: 677-83(1970).

The polarization of the accelerated plasma cluster is examined on the basis of a simple model. The external discharging circuit is also considered, but only the conditions for constant accelerating voltage applied to parallel conductors are solved for the sake of simplicity. The case of an oscillating cluster was investigated for fixed plasma parameters. Polarization energy is not decisive, but the structure of the cluster is influenced by this phenomenon. Also, the impedance influence of plasma is included in the equations. (auth)

30346 COMPUTATION OF CURRENT SHEET SPEEDS IN PLASMA ACCELERATORS. Wolf, R. J. (Univ. of Colorado, Boulder); Sorrell, F. Y.; Nakagawa, Y. AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 807-9(Apr 1970).

A snowplow model was used to calculate the current sheet position and a circuit equation that assumes a fixed external circuit inductance in series with a time-dependent inductance was also used. The speed of the current sheet in a coaxial accelerator was calculated. (M.O.W.)

30347 CONDUCTIVITY OF AN IMPURE, NONEQUILIBRIUM PLASMA WITH ELECTROTHERMAL INSTABILITIES. Bishop, Allan R.; Nichols, Lester D. (Lewis Research Center, Cleveland). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 829-31 (Apr 1970).

The combined effect of impurities and fluctuations on the conductivity of a nonequilibrium flowing plasma was investigated. A steady-state, seeded plasma was assumed to be flowing perpendicular to a uniform magnetic field. A discussion is given of the results. (M.O.W.)

Production

30348 EXPERIMENTAL DETERMINATION OF THE CONDITIONS REQUIRED FOR OBTAINING A PREESTABLISHED ELECTRON DENSITY. Georghiu, Octav C.; Gheorghe, Viorica N. (Inst. of Physics, Bucharest). Compt. Rend., Ser. B; 270: 880-3(6 Apr 1970). (In French).

Electronic tuning gives a convenient means of studying the conditions required for obtaining a given electron density. (France)

30349 ION SOURCES FOR HIGH-TEMPERATURE PLASMA GENERATORS. Denki Gakkai Zasshi; 89-12: 2231-43(Dec 1969). (In Japanese).

In research on nuclear fusion, technological development of ion sources with large current is very significant. In this connection, the following are described: (1) The types of ion source so far developed. Their broad classification is rf discharge-type, hot-cathode-discharge type, and PIG-discharge-type. The first type is further divided into magnetic-field and electric-field coupling types. The second type includes Lamb-Lofgren type and duoplasmatron. The third type includes those with cold or hot cathode. (2) Ion sources for high-temperature plasma generators. The PIG type for HX apparatus has merits of rapid cutting off of ion beams, etc., the large-current source for the DCX apparatus at ORNL, the calutron-type source at UCRL, and cluster ion sources being described. (3) The emittance, brightness, and orbit as factors expressing the property of a large-current ion source, are explained. (NSA of Japan)

30350 PLASMA IONIZATION ENHANCEMENT BY LASER LINE RADIATION. Oettinger, P. E. (Aerospace Corp., El Segundo, Calif.); Dewey, C. Forbes Jr. Contracts F04701-68-C-0200; Nonr 1841(93). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 880-5(May 1970).

The possibility of increasing the degree of ionization in a plasma, by use of incident laser wavelengths matched to specific atomic transitions, is theoretically investigated. Such electron production occurs via a multistep process involving laser excitation of neutral atoms to electronic levels near the continuum and subsequent ionization of these atoms through collisions with thermalized plasma electrons. Detailed calculations for atomic oxygen, nitrogen, carbon, and cesium indicate that present state-of-the-art pulsed lasers are capable of raising 10^{14} to 10^{16} cm^{-3} electron densities by a factor of two. Use of laser-diode and laser-shock tube combinations for diagnostic studies of recombination processes is discussed briefly. (auth)

Stability

Refer also to abstracts 30330 and 30373.

30351 (COO-1695-26) PLASMA INSTABILITIES AND WAVES EXCITED BY AN ANISOTROPIC ENERGY DISTRIBUTION PRODUCED BY ELECTRON CYCLOTRON RESONANCE. Quarterly Progress Report No. 12. Shohet, J. L. (Wisconsin Univ., Madison. Dept. of Electrical Engineering). 15 Mar 1970. Contract AT(11-1)-1695. 39p. Dep. CFSTI.

Theoretical work during this period centered on two major problems: (1) calculation of rf heating rates by analytical means and by computer simulation, and (2) a continuation of the calculations of the free-free bremstrahlung from a relativistic anisotropic plasma. The experimental work has concentrated on developing Langmuir-probe techniques for use on the magnetic mirror device. (M.O.W.)

30352 (IPP-1/100) NUMERICAL CALCULATION OF THE GROWTH RATES OF MHD INSTABILITIES OF A SCREW PINCH. Wilhelm, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug 1969. 28p. (In German). Dep. CFSTI (U. S. Sales Only).

To prove the possibility of a dynamically stabilized high-β torus the growth rates of MHD instabilities for a screw discharge in the region above the Kruskal limit are calcualted. Two cases are treated: in the first case, the whole z current flows through the plasma column; in the second case, it is assumed that the pitch ($\mu = B_\theta/r \cdot B_z$) is constant in the region between plasma column and wall. For these two cases the growth rates of the m = 1 instability are compared for a given relative displacement $\delta = \Delta/r_s$ (r_s = radius of the coil) of the plasma column, defined by the ratio B_z/B_θ at the surface of the column. As further parameters the aspect ratio $A = R/r_s$ (R = major radius of the torus), the value ot β and the compression ratio $\epsilon = r_s/r_p$ (r_p = radius of plasma column) are taken into account. For identical displacement δ it is found that the growth rates in the constant-pitch model are less than in the vacuum case by a factor up to an order of magnitude. (auth)

30353 (IPP-6/81) AN ABSOLUTELY MHD-STABLE AXISYMMETRIC CLOSED FIELD LINE EQUILIBRIUM. Rebhan, Eckhard (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Nov 1969. 17p. Dep. CFSTI (U. S. Sales Only).

The MHD stability of special axisymmetric toroidal equilibria with a hard core and closed field lines is demonstrated. (auth)

30354 STABILIZING PLASMA IN ADIABATIC TRAPS. Ioffe, M. S.; Kadomtsev, B. B. (Kurchatov Inst. of Nuclear Energy, USSR). Usp. Fiz. Nauk; 100: 601-39(Apr 1970). (In Russian).

A brief but comprehensive review is given of the problems related to the collective processes occurring in plasma confined in adiabatic traps. Coulomb collisions, channel plasma instability, methods of plasma stabilization, kinetics of plasma instability, and cyclotron electrostatic instabilities are discussed. The articles also cover data on the cone and drift-cone instabilities, negative-mass instabilities, and hot-electron plasma instabilities, as well as masers with a cyclotron resonance, and the Earth radiation belts. 160 references. (R.V.J.)

Thermonuclear Processes

Refer also to abstract 30186.

30355 (AEC-tr-7148) PULSED THERMONUCLEAR REACTOR OPERATED WITH LASERS. Kaiser, Wolfgang; Opower, Hans. Translation of German Patent 1,900,524. 12p. Dep. CFSTI.

A reactor employing LiD or LiT fuels, using a high power laser beam for excitation, is described. The advantages of the system are discussed. (M.O.W.)

30356 (IPPJ-T-1) ENGINEERING DEVELOPMENTS IN THE QP EXPERIMENTS. Matsuura, Kiyokata; Horikoshi, Gen'ichi; Kuroda, Tsutomu; Sato, Teruyuki; Mizuno, Isao; Ito, Yoshinori; Miyahara, Akira (Nagoya Univ. (Japan). Inst. of Plasma Physics). Oct 1969. 18p. (CONF-680710-10). Dep. CFSTI (U. S. Sales Only).

From 5th Symposium on Fusion Technology, Oxford, England.

In the QP machine, the PIG plasma source of high discharge power (up to 100A/500V) with electron bombardment cathode was constructed to produce the hydrogen plasma with high density ($n_e \sim 10^{13}/cm^3$). The discharge current of the PIG was determined by cathode temperature and the emissivity of cathode materials. Control of the discharge current was attempted by feeding back the discharge current to the electron bombardment power. Further development to get a plasma column with a sharp boundary and uniform radial density distribution was accomplished with an electron bombardment Ta cathode of uniform electron emissivity. To cancel out the temperature rise at the center, a cathode with a material of slightly low emissivity welded at the center was developed. A variable-frequency (1.7 MHz ~ 7 MHz) 50-kW rf power oscillator for the experiment of ion cyclotron resonance heating was constructed. Besides the oscillator tube (NEC 8T72A), another tube of the same type was connected in series in anode circuit to keep output power level constant (±0.1%). A Faraday shield was inserted inside the Stix-type heating coil to reduce the nonresonant coupling between the coil and plasma. To match the inductance of the heating coil (~1 μH), the feeder system of coaxial type, including a vacuum variable condenser, was constructed. (auth)

30357 (JPRS-50255) THERMONUCLEAR REACTOR WITH A PLASMA COLUMN HOVERING FREELY IN A HIGH-FREQUENCY FIELD. Kapitsa, P. L. Translated from Zh. Eksp. Teor. Fiz.; 58: 377-86(1970). 13p. CFSTI.

An abstract of this article from the original Russian appeared in NSA 24: 19916.

30358 (NP-18237) EXPERIMENTAL WORK DONE ON THE TOKAMAK PROGRAM AT KURCHATOV INSTITUTE FROM 1960 TO 1968. Ginot, P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Sep 1969. 55p. Dep. CFSTI (U. S. Sales Only).

The experimental effort in the Tokamak program is described. Memos summarize the main publications. Tables, deduced from the memos, present the work done on each subject, by each author, and on each machine. The text comments on the phases of the progression of the research and the approach used. (auth)

30359 NEGATIVE V'' SYSTEM WITHOUT USE OF TOROIDAL SOLENOID COILS. Mohri, Akihiro (Kyoto Univ.). J. Phys. Soc. Jap.; 28: 1549-58(Jun 1970).

Simple helical currents of same polarity and short pitch produce an average minimum B system by superimposing a vertical magnetic field B_v without use of toroidal coils. Analytically it is shown that the average minimum B is present in case of large aspect ratio and short pitch. Computations of toroidal systems, which have a moderate aspect ratio and l = 3 helical windings, show that a ringless quadrupole configuration and the Taylor's field are both realized by adjusting B_v. The rotational transform angle exceeds π and the mirror ratio is small. (auth)

30360 MAGNETIC SURFACE IN THE MINIMUM MEAN FIELD OF STELLARATOR TYPE AND THE DRIFT SURFACE OF DESIGN STUDY PARTICLES. Miyamoto, Kenro (Nagoya Univ., Japan). Kakuyugo Kenkyu; 24: No. 2, 100-18(Nov 1969). (In Japanese).

The properties of magnetic surfaces in the minimum mean field of stellarators, such as rotational transform, shear, and depth of magnetic well, were analyzed in regard to their dependence on the current and geometrical parameters of current configuration, and to the range of values they can take. Comparison was made with the result of numerical calculation. A criterion was given for the Larmor radius in order that the deviation of drift surface from the magnetic surface is made small. The effect of geometrical error on the magnetic surface was numerically estimated for a model of current configuration, and the evaluation of permissible errors was attempted. (NSA of Japan)

30361 DEUTERON ACCELERATION AND NEUTRON PRODUCTION IN PINCH DISCHARGES. Bernstein, Melvin J. (Aerospace Corp., El Segundo, Calif.). Phys. Rev. Lett.; 24: 724-7 (30 Mar 1970).

Deuteron trajectories were calculated for the crossed electric and magnetic fields generated by a rapidly constricting current distribution in a z-pinch discharge. The results show that many ions are accelerated to high energies with a large value for their time-averaged axial velocity. A neutron-production model, based upon nuclear collisions by these deuterons, easily accounts for the observed characteristics of neutron emission. (auth)

30362 FURTHER INVESTIGATIONS ON LOW-DENSITY HALL ACCELERATORS. Koehne, R.; Lindner, F.; Schreitmueller, K. R.; Wichmann, H. G.; Zeyfang, E. (Institut fuer Energiewandlung und Elektrische Antriebe, Stuttgart). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 873-9(May 1970).

Based on theoretical considerations, the dependence of the thruster efficiency on the magnetic field and on the length of the accelerator channel was calculated. To reduce the anomalous electron backflow an external ion source should be used, which produces a homogeneous ion beam. This can be obtained by an annular plasma source with a slit hollow cathode. Experiments were carried out on two different accelerator types. The plasma properties in the exhausted beam were measured using probes and spectroscopic methods. The ion velocity distribution was measured by a retarding-potential method. For the determination of thrust, a pendulum was used. Further experiments were performed on ion sources. (auth)

Wave Phenomena

Refer also to abstracts 30318 and 30351.

30363 (AD-685766) CYCLOTRON HARMONIC EMISSION AND ABSORPTION PHENOMENA IN A NON-UNIFORM DENSITY PLASMA. Alper, Ali T. (Case Western Reserve Univ., Cleveland, Ohio. Div. of Electrical Sciences and Applied Physics). Jan 1969. Contract F19628-68-C-0088. 157p. (AFCRL-69-58). CFSTI.

Cyclotron harmonic wave generation by nonrelativistic fast electrons in a warm, collision-free, nonuniform electron density plasma slab is investigated. Ion motion is neglected and investigations are confined only to frequencies near the second cyclotron harmonic. The power absorption within, and power emission out of the plasma slab via mode conversion is calculated, including the effects of cyclotron damping caused by propagation of the waves in a direction not quite perpendicular to the static magnetic field. The transmission properties of the plasma slab for an incident electromagnetic field are determined. By making use of the "fluctuation-dissipation" theorem the fast-electron temperature is estimated from a comparison of the cyclotron harmonic emission and absorption spectrums. In order to make a comparison with experimental observations, electromagnetic wave propagation through the plasma slab is analyzed. Similarities of the calculated power absorption spectrum with experimental results are verified from the plots of the electric fields. (auth) (USGRDR)

30364 (AD-696150) VELOCITY SPACE DIFFUSION AND LANDAU DAMPING IN COLLISIONAL PLASMAS. Li, Kwok-Leung; Jen, Norman C. (City Coll., New York. Dept. of Civil Engineering). 1 Sep 1969. 63p. (AFOSR-69-2734-TR). CFSTI.

The statistical behavior of a completely ionized plasma in which collisional effects are included is described by the Vlasov equation coupled to the Poisson equation, terms suggested by the Krook relaxation model and the isotropic Fokker-Planck model being chosen as collision operators. As a result of perturbations on the background distribution function, longitudinal oscillations are set up and the plasma diffuses in velocity space as a consequence of wave-particle interactions. The coupled equations are solved by the method of characteristics in the Fourier transformed space employing the quasi-linear approximation developed by Drummond, Pines, Vendenov, Velikhov and Sagdeev. The longitudinal behavior of the plasma is followed into the quasi-linear regime in which both collisional and collisionless Landau damping and velocity space-diffusion mechanisms are investigated. The rate of dissipation is shown to have collisionless as well as collisional attributes. (auth) (USGRDR)

30365 (IPP-6/82) DISPERSION RELATION OF AN INHOMOGENEOUS VLASOV PLASMA. Croci, R.; Saison, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Nov 1969. 23p. Dep. CFSTI (U. S. Sales Only).

An integral equation for the electric potential in Laplace-Fourier space is derived for the class of distribution functions: $F_{0j} = g_j(v_\perp^2; v_\parallel^2) \exp\{-a|\int_0^x (B_z(x')/B_0)\,dx' + (m_j v_\parallel/e_j B_0)|\}$; j = e, i (which lead to density profiles everywhere infinitely differentiable). The problem of the stability of the solutions reduces to de-

termining the singularities, in the ω plane, of the solutions. A necessary and sufficient condition for the existence of singularities not independent of K_x is obtained. The problem is greatly simplified in the case of quasi neutrality. (auth)

30366 WAVES IN A TWO-TEMPERATURE PLASMA WITH PERIODIC ELECTRIC FIELD. Das, K. P. (Government Engineering Coll., Jalpaiguri, India). J. Phys. Soc. Jap.; 28: 1541-8(Jun 1970).

Starting from two-fluid model hydrodynamic equations, a dispersion relation is obtained for wave propagation through a two-temperature plasma perpendicular to the direction of an external electric field $E_0 \cos \omega_0 t$ and several excitation conditions are deduced for small values of the parameter $\epsilon = ek E_0/m_e\omega_0^2$, in which k is the wave number and e, m_e are the charge and mass of an electron. (auth)

30367 COLLISIONAL DAMPING OF PLASMA OSCILLATIONS. Bogdanor, John L.; Willett, Joseph E. (Univ. of Missouri, Columbia). J. Appl. Phys.; 41: 2601-5(May 1970).

An analysis of electrostatic oscillations in a weakly ionized plasma is based on the Boltzmann–Vlasov (BV) equation with electron–neutral collisions accounted for by a simplified form of the Lorentz-gas Boltzmann-collision integral. The isotropic scattering contribution to the collision integral is treated exactly while the anisotropic scattering contribution is approximated by assuming a weakly anisotropic electron velocity distribution. The collisional damping decrement is found to be equal to $-\nu_1/2 + 3\nu_1 k^2 v_t^2/\omega_p^2 - (11/3)\nu_2 k^2 v_t^2/\omega_p^2$ to second order in the wave number k where v_t is the electron thermal velocity, ω_p is the plasma frequency, and ν_1 and ν_2 are precisely defined averages of the collision frequency for momentum transfer. An alternative method of analysis based on the simultaneous used of the BV equation and the moment equations is also illustrated. (auth)

30368 DYNAMIC POTENTIALS IN GYROTROPIC PLASMA. Bevc, Vladislav (Aerospace Corp., Los Angeles). J. Appl. Phys.; 41: 2408-15(May 1970).

Wave equations are derived for the scalar and vector potentials of guided electromagnetic waves propagating in a laterally bounded magnetized plasma along the axis of the static magnetic field. Solutions are given in the Coulomb and the Lorentz gauge. These solutions are used in a critical examination of the conceptual basis of the quasi-static theory because they allow coavenient partitioning of the high-frequency electric field into a lamellar and a rotational part. In the quasi-static approximation the electric field is considered to be entirely lamellar, i.e., the gradient of a scalar potential that is not consistent with Maxwell's equations. To avoid inconsistencies, the problem is formulated so that the dynamic scalar potential replaces the quasi-static potential. The rotational part of the electric field is readily obtained as the time derivative of the vector potential. Exact quantitative comparison of two parts of the electric field is made possible in this way and the relative importance of each part is evaluated for a few typical cases of interest. There exist some waves with dispersion characteristics that can not be obtained with the quasi-static formula although the condition that the phase velocity be smaller than the velocity of light presumed to be necessary for the applicability of the quasi-static approximation is satisfied. In these waves the rotational part of the electric field is comparable or greater than the lamellar part. Conversely, in modes with dispersion characteristics that can be well approximated with the quasi-static formula even when the phase velocity exceeds the velocity of light the lamellar part of the electric field is much larger than the rotational part. It can be inferred that the essential element of the quasi-static theory is the assumption that the high-frequency electric field is predominantly lamellar rather than the condition that the phase velocity be smaller than the velocity of light and related criteria. (auth)

30369 SURFACE WAVES ON FLUCTUATING PLASMAS. Anicin, B. A.; Ilic, D. B. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Appl. Phys.; 41: 2737(May 1970).

The propagation of electromagnetic surface waves on plasma columns density modulated in time was studied. Experiments indicate strong correlation between the first derivative of surface wave cw interference plots and surface wave records obtained with harmonic density modulation. This property is explained with a simple theory based on the equations of propagation on the surface waveguide. (M.O.W.)

30370 SYDNEY UNIVERSITY STUDIES OF THE PROPAGATION OF ELECTROMAGNETIC WAVES IN LABORATORY PLASMAS. Cross, R. C.; Watson-Munro, C. N. (Univ. of Sydney). At. Energy Aust.; 13: 2-9(Apr 1970).

The propagation of small-amplitude electromagnetic waves ranging from about 100 kc in the magnetohydrodynamic region, to optical frequencies, is discussed. Ionospheric and other extraterrestrial observations have, for some time, indicated the influence of electron density and magnetic field on plasma wave propagation. Plasma description from Boltzmann's equation is shown, with modifications by the continuity and Maxwell equations. The dispersion relations predicted were experimentally confirmed over a frequency range 10^5 sec^{-1} to 10^{15} sec^{-1}. Characteristic frequencies for hydrogen plasma at B_0 = 10 kilogauss are tabulated. (Australia)

30371 DISPERSION RELATION FOR LONGITUDINAL WAVES IN A RELATIVISTIC PLASMAS. Gupta, R. M. (Univ. of Rajasthan, Jaipur, India). Z. Phys.; 235: 66-8(1970).

Imre, Buti and others studied the longitudinal waves from the general dispersion relation. Here, the dispersion relation is derived for the longitudinal waves in relativistic plasmas, a result which cannot easily be brought in a physically more convenient form. (auth)

30372 EXACT SOLUTION OF THE PROBLEM OF ACOUSTIC WAVE PROPAGATION THROUGH THE POSITIVE COLUMN OF DISCHARGE. Aubrecht, L. (Technical Univ., Prague). Czech. J. Phys.; 20: 694-701(1970).

The propagation of acoustic waves in the three-component plasma is studied theoretically. An exact solution of a system of basic equations is obtained and analyzed. It is shown that a group of waves can propagate in the plasma with amplitudes depending proportionally on the excitation wave amplitude. (auth)

30373 EXPLOSIVE INSTABILITIES IN THE WELL-DEFINED PHASE DESCRIPTION. Wilhelmsson, H. (Uppsala Univ.); Stenflo, L.; Engelmann, F. J. Math. Phys. (N. Y.); 11: 1738-42 (May 1970).

A general theoretical investigation was made of 3-wave interaction in the well-defined phase description, with special regard to nonlinear explosive instabilities in the presence of linear damping or growth. (auth)

Shielding

Refer also to abstracts 29422, 29486–29494, 29927–29929, 29948–29950, 30003, 30033, 30414, 30649, and 30671.

30374 (AD-700123) THE PREPARATION OF SIMPLIFIED MANUALS FOR SHIELDING ANALYSIS. Summary Report, May 1967–March 1968. Report No. 4895-1. Starbird, A. W.; Batter, J. F. (Conesco, Watertown, Mass.). Contract DAHC20-67-C-0180. 77p. CFSTI.

An analysis was made on the effects of finite rectangular fields of contamination on the radiation-shielding characteristics of shelters. Emphasis was placed on the basement and upper-story shelter areas where the wall-scattered radiation component is generally predominant. Finite-field, engineering-method shelter calculations were compared with results obtained by using the CONSTRIP computer code, and each of the engineering-method parameters were investigated to determine which might be responsible for the differences observed between comparable attenuation values calculated by the two methods. (auth) (USGRDR)

30375 (COO-2049-1) FAST NEUTRON TRANSMISSION MEASUREMENTS FOR REACTOR CORE AND SHIELDING MATERIALS. Technical Progress Report. Meyer, W. (Kansas State Univ., Manhattan. Dept. of Nuclear Engineering). Feb 1970. Contract AT(11-1)-2049. 51p. Dep. CFSTI.

Work is described on: the definition of the "standard neutron penetration experiment," optimization of neutron spectrometer operating characteristics, intercalibration of the KSU NE-213 fast-neutron spectrometer with the spectrometers of other laboratories, re-evaluation of existing methods and structuring of new methods of complex neutron spectrum unfolding, study of approximate and direct design methods applicable to neutron transport problems, and measurement of neutron penetration spectra. Existing transport codes ANISN and SLABO were adapted to the Kansas State University (KSU) 360/50 computer and θ and ϕ angular-dependent invariant-imbedding neutron transport code was developed. The applicability of one-dimensional and two-dimensional discrete ordinate (S_n) codes and Monte Carlo codes to various experimental neutron penetration geometries being considered at KSU was studied. Cross section library tapes and access codes were transferred to the KSU Computing Center. (M.H.R.)

30376 (ORNL-TM-2781) TIME-DEPENDENT NEUTRON AND SECONDARY GAMMA-RAY TRANSPORT IN INFINITE AIR AND IN AIR OVER GROUND. Straker, E. A. (Oak Ridge National Lab., Tenn.). 7 May 1970. Contract W-7405-eng-26. 45p. Dep. CFSTI.

The general description of the radiation field was determined for several neutron source energies in infinite air and in an air-over-ground geometry for source heights of 50 and 1125 feet. The effect on dose of source height and detector height and the effect of the ground on energy, angular, and time dependence are discussed for both fission and 12.2- to 15-MeV neutron sources. The satisfactory agreement of calculations with experimental results from operations BREN and HENRE and the agreement between Monte Carlo and discrete ordinates results lend confidence to the cross sections used and the computational techniques. (auth)

30377 USE OF GAUSS–LAGUERRE NUMERICAL INTEGRATION FOR POINT KERNEL SHIELDING CALCULATIONS. Cochrane, P. C.; Mesh, D. W. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng.; 40: 478-83(Jun 1970).

An attempt is made to streamline the numerical (computer) evaluation of the point kernel integration in arbitrary geometries. Numerical integration techniques are reviewed briefly. The effectiveness of Laguerre polynomials for approximating point kernel fluxes is demonstrated. (M.H.R.)

Solid-State Physics

Radiation Effects

Refer also to abstracts 29514, 29535, 29606, 29614, and 29615.

30378 (N–70-15784) INVESTIGATION OF THE DETECTIVITY OF RADIATION-PRODUCED DEFECT LEVELS IN n- AND p-TYPE SILICON AND GERMANIUM. Final Report. Mattauch, Robert J. (Virginia Univ., Charlottesville. Research Labs. for the Engineering Sciences). Jul 1969. 133p. (NASA-CR–66884; EE–4031-103-69-U). CFSTI.

The spectral results for n-type silicon that occur at the onset of increased photoconductivity for a wavelength of 0.42-eV energy are reported. The spectral results for p-type silicon show the highest spectral response for infrared photons when the energy is greater than 0.27 eV. It is concluded that the black-body responsivity of silicon is high in comparison with that for germanium. In addition, a thesis on the possibility of using irradiated silicon as a photoconductive infrared detector is included. The thesis concludes that irradiated silicon promises definite possibilities as a useable photoconductor. (STAR)

30379 RADIATION DAMAGE IN SOLIDS. I. A NOTE ON DISPLACEMENT SPIKE. Watanabe, Yoshio; Taniguchi, Akira (Tokai Univ., Tokyo). Tokai Daigaku Kiyo Kogakubu; 1969: No. 1, 35-41(Mar 1970). (In Japanese).

Conventionally, two different models are employed in calculations of radiation-damage theory. One consists of individual or atomic scatterings such as the approximation by Snyder–Neufeld et al., while the other is based on collective damage such as the displacement spike by Brinkman et al. In fact, the phenomena of damage are very complicated in mechanism, and each of the points of view mentioned above is considered to represent an extremely simple case. In a sense, radiation damage is an effect resulting from the stochastic collision process, which in the sequence of individual collisions includes the correlative character causing local regular damage such as spike and directionally regular damage such as resulting from focusing collisions. In the opinion of the authors, locally collective damage should be explained on the basis of the stochastic collision process, and an attempt is made to derive the Brinkman model on some assumptions different from those of Brinkman so as to substantiate their opinion. It is found that the Brinkman model results only in some cases, that is, whether the Brinkman model is valid or not depends principally upon the scattering cross section. (auth) (NSA of Japan)

30380 DEFECT PRODUCTION DURING LOW TEMPERATURE ELECTRON IRRADIATION. PART II. THE INFLUENCE OF RADIATION DOPING ON THE DEFECT PRODUCTION IN ALUMINIUM, COPPER, AND PLATINUM. Duesing, G.; Hemmerich, H.; Sassin, W.; Schilling, W. (Kernforschungsanlage, Juelich, Ger.). Cryst. Lattice Defects; 1: 135-44(Mar 1970).

In order to clarify which processes determine the radiation annealing at high defect concentrations, the resistivity increase per unit dose was measured in samples of high-purity aluminum, copper, and platinum during irradiation with 2.8-MeV (Al and Cu) and 3-MeV (Pt) electrons at temperatures below 9°K. The effect of stepwise annealing of close Frenkel pairs in combination with low-dose test irradiations show that three different processes influence the defect buildup: (a) spontaneous recombination of the vacancy or the interstitial of a Frenkel pair which are produced within the recombination volume of an existing respective recombination partner; (b) recombination of close Frenkel pairs by subthreshold recoil events; the cross section for this process depends on the detailed configuration of a pair, the configuration with the lowest thermal stability (substage I_A) leading to the highest recombination probability; (c) transformation of close Frenkel pairs by subthreshold recoil events from one stable configuration into another one. These processes lead to the redistribution of the population of the different close pair configurations and thereby influence indirectly the production rate via mechanism (b). (auth)

30381 DEFECTS IN COBALT DOPED X-IRRADIATED NaCl CRYSTALS. Jain, S. C. (Solid State Physics Lab., Delhi); Lal, Krishan. Cryst. Lattice Defects; 1: 165-75(Mar 1970).

X-irradiated NaCl crystals show a new relaxational loss peak designed as S peak, in the tan δ versus frequency isothermals. The S peak is observed on the higher-frequency side of the two loss peaks (labeled as A and B peaks) observed in unirradiated Co-doped NaCl crystals. The S-peak is not observed in pure (irradiated) crystals and increases in intensity with the concentration of cobalt and with time of x irradiation. From the slope of the straight line obtained by plotting log f_{sm} versus $1/T$ (f_{sm} being the peak frequency of the S peak), the value of activation energy is found to be 0.90 ± 0.04 eV. The creation of S centers is accompanied by a reduction in the heights of the A and the B loss peaks and a decrease in the electrical conductivity of the crystal. On heating the crystal to ~200°C, the S centers disappear and the conductivity and heights of the A and B peaks are partially restored to their original values. In the optical absorption spectrum, the S centers show a band at 210 nm. The heights of the 210-nm optical band and the S peak vary proportionally. On x irradiation, highly pure crystals doped with Co showed an EPR line due to S centers superimposed on the F center EPR line. The g-value of the former is 2.049 ± 0.002 and half width is 62 ± 3 gauss. The observed properties of the S centers are consistent with the model $Co^+ + -$ (+ and – are cation and anion vacancies, respectively). The behavior of heavily x-irradiated Co-doped NaCl crystals is different. New centers designated as C centers are produced on bleaching the heavily x-irradiated crystals. C centers show an optical absorption band at 200 nm and a Lorentzian EPR line with a g-value 2.14 ± 0.01. The half width of the EPR line of C centers decreases with increase in temperature of thermal bleaching. The concentration of the centers is maximum at ~150°C. On bleaching the crystals at 270°C or above, the C centers disappear. C centers appear to be loosely bound clusters of Co^+ centers. (auth)

30382 INFLUENCE OF A THERMALLY ACTIVATED BACK-REACTION ON THE FIRST-STAGE F-COLOURING OF NaCl. Sanchez, C.; Agullo-Lopez, F. (Junta de Energia Nuclear, Madrid). Cryst. Lattice Defects; 1: 177-84(Mar 1970).

The effect of a thermally activated process of trapping of free anion vacancies, liberated by radiation, on the shape of the F growth curve of NaCl, was investigated. The experimental method consists in coloring the crystals through an orderly sequence of constant irradiation and interruption times (coloring sequence). It was found that conspicuous radiation-induced F-center bleaching is produced by this procedure. Furthermore, the saturation value of the initial stage F-center coloring depends on the sequence used to color the crystal. The results can be satisfactorily accounted for within a model previously proposed for the slow component of the first-stage F coloring. (auth)

30383 REFLECTION OF ENERGETIC PARTICLES FROM ATOMIC OR IONIC CHAINS IN SINGLE CRYSTALS. Varelas, C.; Biersack, J. (Hahn-Meitner-Inst., Berlin). Nucl. Instrum. Methods; 79: 213-18(1970).

The channeling of p- and α-particles in Al, Au, Cu, MgO, LiF is theoretically investigated. Computer studies and analytic approximations were carried out to obtain the critical angle and the distance of closest approach to a lattice row. All calculations presented are based upon single collisions with the lattice atoms or ions. This treatment is considered especially reliable in very close encounters, i.e., high particle energies and/or thermal vibrations of lattice atoms. Electronic stopping could be taken into account. The Lenz–Jensen potential was generalized for easier application. (auth)

30384 ANNEALING OF ELECTRICAL CONDUCTANCE CHANGE IN γ-IRRADIATED LEAD NITRATE. Mohanty, S. R.; Nair, S. M. K. (Utkal Univ. Bhubaneswar, India). J. Inorg. Nucl. Chem.; 32: 1747-9(May 1970).

In the case of simple inorganic crystals such as the alkali halides, thermal annealing of the irradiated crystals results in reversion of the electrical conductivity to near its original value. It was of interest to investigate this effect in more complex systems, such as those containing compound ions, together with an-

nealing of chemical damage. Lead nitrate was chosen for the study since its annealing mechanism is fairly simple. Irradiation was to 50 MR with ^{60}Co γ rays at a dose rate of 1.5 MR/hr in sealed glass tubes. Annealing was either isothermal or at a constant heating rate of 4°C/min. The room temperature conductance decreased to about half value on irradiation, but partially recovered on heating at 150°C for 5 hours and almost completely on heating for 25 hours. The fraction of the chemical damage annealed in 25 hours at this temperature was, however, only 0.2. Conductance data obtained while the temperature increases at constant rate are shown graphically. The electrical conductance of a crystal is a direct measure of positive ion vacancies, and it would therefore appear that there are fewer free positive ion vacancies subsequent to irradiation. Mechanisms are briefly discussed. (UK)

30385 DEFECT PRODUCTION DURING LOW-TEMPERATURE ELECTRON IRRADIATION. PART I. SPONTANEOUS RECOMBINATIONS AND RECOMBINATIONS OF FRENKEL DEFECTS BY SUBTHRESHOLD RECOIL EVENTS. Duesing, G.; Sassin, W.; Schilling, W.; Hemmerich, H. (Kernforschungsanlage, Juelich, Ger.). Cryst. Lattice Defects; 1: 55-68(Dec 1969).

The buildup of Frenkel defects during electron irradiation at 4.5°K in pure aluminium, copper, and platinum is studied by electrical resistivity measurements. The highest electron doses achieved are 10^{20} cm^{-2}. The dose curve of the electrical resistivity shows a definite approach to saturation. The reduction of the effective defect production rate with increasing Frenkel defect concentration that leads to this saturation is analyzed by means of radiation-doping experiments (Al, Cu, and Pt) and subthreshold test irradiations (Pt). It is shown that the effective production rate of defects at high doses is reduced in these metals essentially by two mechanisms: spontaneous recombination of nearby vacancies and interstitials and collapse of close Frenkel pairs resulting from subthreshold energy transfers to nearby lattice atoms during the electron irradiation. Values for the spontaneous recombination volumes and the cross sections for subthreshold recombination processes are reported for Cu, Al, and Pt. Doping of platinum with vacancies by quenching prior to irradiation enhances the number of spontaneous recombinations, thus reducing the defect production rate during electron irradiation. In addition, at low doses, vacancy doping gives rise to an apparent increase of the damage rate, which is probably caused by an increased value of the resistivity per Frenkel pair in the prequenched samples due to deviations from Matthiessen's rule. (auth)

30386 ESR SPECTRA OF IRRADIATED BORAX POWDER, DIBORATE GLASSES, AND DEVITRIFIED SAMPLES. Arafa, S.; Bishay, A. (American Univ., Cairo). Cryst. Lattice Defects; 1: 91-103(Dec 1969).

A structureless ESR line was observed at $g \simeq 2.00$ in gamma-irradiated borax powder. This line is rather unstable and its intensity reaches a saturation after about 10^6 rads of gamma irradiation. On the other hand, the ESR hyperfine structure characteristic of borate glasses was observed in the irradiated borax powder only under the following conditions: (a) irradiating the powder to a high dose ($\geq 10^8$ rads), (b) measuring the ESR spectrum of the irradiated powder at −160°C, or (c) heating the powder before irradiation and then measuring the induced ESR spectrum at room temperature. These observations were related to changes in structure. A doublet was observed in the ESR spectrum for the irradiated powder when measured at −160°C. This doublet may be attributed to atomic hydrogen trapped at interstitial positions. Comparison of the induced ESR spectra of the irradiated glasses with that for the corresponding irradiated devitrified samples (obtained by heat treating the glasses) supports the idea of similar structural groupings in the glass and the corresponding crystals formed as a result of devitrification. In the glass, these structural groupings may experience different degrees of deformation and are possibly connected to each other in a random way. (auth)

30387 TRANSIENT F → M CONVERSION INDUCED IN NaCl BY A SEQUENCE OF SHORT γ IRRADIATIONS AND INTERRUPTIONS TIMES. Sanchez, C.; Agullo-Lopez, F. (Junta de Energia Nuclear, Madrid). Cryst. Lattice Defects; 1: 109-12 (Dec 1969).

The influence of a process of free anion vacancy trapping on the kinetics of the complex M and R bands was investigated by means of a sequence of interruptions and short irradiations. In particular, a considerable F → M conversion has been obtained with this method. (auth)

30388 APPLICATION OF COLOR-CENTER PHENOMENA. Ideda, Toshio (Tohoku Univ., Sendai). Oyo Butsuri; 38: 1165-7(Dec 1969). (In Japanese).

Some recent applications of color-center phenomena are reviewed. The formation of F-center in alkali halide crystals by electron-beam irradiation was applied to dark-trace tubes. Recent contributions by Uno et al., and by the author are discussed. Schneider proposed to use the dichroism in the M_A center of KCl, in which the polarized light of different wavelength can be used to write in, and to read out information. An information capacity of 10^8 bits/cm^2 is possible. The application of the F center in KBr−H to holographic recording was attempted by Kalman. Three-dimensional recording with high resolution is possible with the F center. The applications to dosimetry, lasers, study of lattice defects, and other fields are discussed. (NSA of Japan)

30389 ISOCHRONAL RESISTIVITY STUDY OF DEFECT RECOVERY IN HIGH-NEUTRON-FLUENCE IRRADIATED MOLYBDENUM. Keys, L. K.; Moteff, J. (Univ. of Cincinnati). J. Appl. Phys.; 41: 2618-26(May 1970).

An isochronal resistivity study from ~70 to 1200°C was completed on molybdenum irradiated at ~70°C to fast neutron ($E_n \geq$ 1 MeV) fluences from 1.1×10^{19} to 1.5×10^{21} n/cm^2. For all but the highest fluence specimen, three major recovery regions are observed at about 0.15 T_m (Stage III), 0.22 T_m, and 0.31 T_m (Stage IV). It is considered that the lowest temperature region results from the recovery of self interstitials, and that the highest-temperature region represents excess-monovacancy recovery if there is an excess, with possible contributions from the recovery of defect clusters. The intermediate region could contain contributions from recovering divacancies. An anomalous saturation effect occurs at $\sim 5 \times 10^{19}$ to 10^{20} n/cm^2 ($E_n \geq 1$ MeV) with a drop-off in the radiation-induced resistivity increment fraction at high fluences. This drop-off in resistivity appears to result from the saturation and complete irradiation annealing of the Stage III defect due to its high mobility at the relatively high homologous-irradiation temperature (0.12 T_m) leaving essentially only a large recovery in the region of Stage IV after irradiation to the highest fluence. A nonannealing residual resistivity increment observed for the highest fluence specimen is attributed to the presence of Tc (and possible Ru) formed via thermal neutron (n,γ) reactions. (auth)

30390 PHOTOCONDUCTIVITY IN NEUTRON-IRRADIATED p-TYPE Si. Cheng, L. J.; Swanson, M. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Appl. Phys.; 41: 2627-35(May 1970).

Photoconductivity spectra of p-type silicon after fission-neutron irradiation at ~13°K and isochronal annealing up to 360°K were measured in the wavelength range 1.2 to 5 μ. Neutron irradiation increases the photoconductivity in the measured wavelength range. The 3.9-μ photoconductivity band, which was correlated with the divacancy, appears immediately after the irradiation and starts to grow upon annealing around 170°K. The growth rate becomes rapid around 350°K. The energy level at $E_v + 0.42$ eV, which was correlated with interstitial dopant atoms, also appears immediately after the irradiation and grows upon annealing in the temperature range 250 to 360°K. The results indicate that the neutron damage region is localized, and they are consistent with a model in which the outer part of the region consists of a divacancy-rich region surrounded by an interstitial-rich region. The presence of shallow traps in neutron-irradiated silicon was assumed in order to explain the temperature dependence of the photoconductivity. (auth)

30391 B-CENTER RADIATION FORMATION MECHANISM IN SILVER-DOPED ALKALI HALIDE CRYSTALS. Muradov, S. M.; Muradova, M. Kh.; Elango, M. A. (Inst. of Physics and Astronomy, Tartu). Sov. Phys.-Solid State (Engl. Transl.); 11: 2553-6(May 1970).

Translated from Fiz. Tverd. Tela; 11: 3149-53(Nov 1969).

The B-center (Ag^- ions at anion lattice sites) formation mechanism in KCl:Ag crystals was studied during x irradiation and in previously irradiated crystals during the optical destruction of F and E centers. It was concluded that the B-center formation takes place in four stages: 1) movement of Ag^+ ions into interstitial sites during the radiationless recombination of electrons with Ag^{++} centers; 2) formation of precenters by the migration of anion vacancies to the interstitial Ag^+ ions; 3) formation of metastable B centers (B_M center) by the capture of two electrons by the precenters; and 4) conversion of B_M centers into B centers by movement of interstitial Ag^- into the anion vacancies. The previously unknown B_M centers giving absorption bands with their maxima at 4.15 eV in KCl:Ag, 3.96 eV in RbCl:Ag, and 3.98 eV in KBr:Ag were detected and studied. (auth)

30392 INTERACTION BETWEEN B ATOMS AND DEFECTS PRODUCED BY Hg BOMBARDMENT IN SILICON. Della Mea, G. (Univ., Padua); Drigo, A. V.; Mazzoldi, P.; Nardelli, G.; Zannoni, R. Appl. Phys. Lett.; 16: 382-3(15 May 1970).

The lattice disorder produced by 42-keV Hg ions implanted in B-doped Si at room temperature was measured by means of

channeling and backscattering of 2-MeV He ions. An annealing effect related to the B concentration is observed. (auth)

30393 ENERGY SPECTRUM OF CATHODE SPUTTERING PRODUCTS DURING BOMBARDMENT OF A METAL BY HEAVY IONS. Veksler, V. I. (Tashkent State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 11: 2540-6(May 1970).

Translated from Fiz. Tverd. Tela; 11: 3132-40(Nov 1969).

The energy spectrum of the atomic products of cathode sputtering from a polycrystalline sample is treated on the basis of a simplified cascade–focuson scheme during bombardment by heavy ions with energies $\epsilon_0 \leq 10$ keV for different values of the angle between the direction of motion of the primary ions and the analyzed secondary atoms. If it is assumed that the velocity of a sputtered atom which leaves the surface of the metal affects the probability that it is ionized, the corresponding spectra of ionic cathode sputtering products can also be calculated. The results obtained agree well with experimental data given in the literature. The calculated values of the energy threshold for cathode sputtering and the dependence of the cathode sputtering coefficient on ϵ_0 also agree with experiment. (auth)

30394 CHANNELING OF LIGHT IONS IN GERMANIUM. Abroyan, I. A.; Koryukin, V. A.; Ushakov, N. N.; Tsekhnovicher, L. A. (Leningrad Polytechnic Inst.). Sov. Phys.-Solid State (Engl. Transl.); 11: 2745-6(May 1970).

Translanted from Fiz. Tverd. Tela; 11: 3376-9(Nov 1969).

The angular dependences of photoconductivity and secondary emission of Ge crystals bombarded by H, He, and Li ions at 1 to 8 keV were determined. The graph of the secondary emission coefficient β vs incidence angle ϕ show the appearance of scattering angles of higher indices as the ion energy is increased. A graph of the angular width ψ vs energy show a line of slope of -0.25, in agreement with the predicted $E^{-\frac{1}{4}}$ dependence for the critical channeling angle, which is about half of the experimental ψ values. (D.L.C.)

30395 VOLUME CHANGE OF ALKALI HALIDE CRYSTALS DUE TO CREATION OF LATTICE DEFECTS BY LOW-ENERGY RADIATION. Balzer, R. (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 234: 242-60(1970). (In German).

Defects were created in the alkali halides KBr and KCl by x irradiation. The type of disorder was determined by combined lattice parameter and length change measurements. The change of the lattice parameter was determined by the shift of a Bragg reflex, and the length change was detected by an inductive transducer. To omit thermal annealing and conversion of defects, the crystals were irradiated below 10°K. Defects are created as Frenkel defects. They anneal in distinct annealing stages, and this Frenkel disorder remains unchanged during annealing. Volume change and lattice distortion due to different defects are obtained by combined absorption and length change measurements. In KBr, the volume change of two different Frenkel pairs was detected. A pair consisting of α- and I-center causes the volume change $(\Delta v)_{\alpha+I} = 3.2$ atomic volumes and a pair of F- and H-center $(\Delta v)_{F+H} = 1.2$ atomic volumes. (auth)

30396 SOME INFORMATION ON THE LATTICE RESTORATION PROCESS IN ALKALI HALIDE CRYSTALS SUBJECTED TO RADIATION DECOMPOSITION. Kozlov, Yu. F. Izv. Tomsk. Politekh. Inst.; No. 170, 84-9(1969). (In Russian).

The absorption spectra of pure KCl, KBr, NaBr crystals, and crystals with various impurities were investigated after a reactor neutron irradiation with integral flux of 3×10^{18} to 3×10^{19} cm^2 at 15 to 30°C. The kinetics of defect annealing, in which three stages can be distinguished, was traced from the spectra of irradiated KBr crystals, taken at various temperatures in the 220 to 450°C range. Filling of the optically undetectable traps with electrons of decaying electron centers takes place in the first stage. Concentration of traps effectively active at temperatures below 200°C is either constant or varies slightly with increasing dose. Electrons remaining after filling the traps at the first stage are captured by divalent cations in the second stage. The beginning of the third stage is similar to additive coloration. The newly formed F centers participate in the formation of the metallic phase. The restoration at this stage is characterized by the interaction between an ensemble of pores and metallic particles. Reactor-irradiated alkali halide crystals with impurities represent an interesting material for a study of impurity centers. In the case of KCl, the F ⇌ Z-center transition is possible in the presence of an anion vacancy connected with a divalent cation. (JPRS)

30397 AVERAGE TRITON ENERGY DEPOSITED IN SILICON PER ELECTRON-HOLE PAIR PRODUCED. Smithrick, John J.; Myers, Ira T. (Lewis Research Center, Cleveland). Phys. Rev., B; 1: 2945-8(1 Apr 1970).

The average triton energy required to produce an electron–hole pair in silicon was measured. The measured value was 3.64 ± 0.04 eV. Precision charge calibration of the amplifier system, plus a special experimental method for correcting for dead-layer losses in the detector, was used to improve the accuracy of the result. (auth)

30398 IDENTIFICATION OF SILICON CARBIDE PHASES BY PROTON BLOCKING PATTERNS. Barrett, C. S. (Univ. of Chicago); Barrett, Marjorie A.; Mueller, R. M.; White, W. J. Appl. Phys.; 41: 2727-8(May 1970).

Individual blocking patterns made by 100- or 150-keV protons backscattered from SiC crystals were used to identify the phase at the irradiated spot and to distinguish the structure type from the >50 other SiC structure types. Nuclear emulsions of the Kodak NTA-type with protective gelatin overcoating which discriminates against protons with energies ≤50 keV, were used. The α-SiC or 6H hexagonal structure and the 15R rhombohedral structure were identified for the (00.1) plane parallel to the film. Imperfection, stacking disorder, and twinning appeared to be insignificant. (D.L.C.)

30399 PHOTOLUMINESCENCE OF AgCl CRYSTALS AFTER X-RAY IRRADIATION. Vinduskova, O. (Charles Univ., Prague). Czech. J. Phys.; 20: 755-6(1970).

Thin monocrystal AgCl monocrystals were irradiated with up to 70×10^3 R x rays and the photoluminescence at 518 and 468 nm following uv excitation was measured. The x irradiation was found to increase both luminescent peaks equally up to 30×10^3 R; above that dose, the luminescence decreases and colloid silver forms on the crystal surfaces. The half width of the 518 nm peak also increases with dose. (D.L.C.)

Physical Properties

Refer also to abstracts 29260, 29925, 29971, 30027, 30673, and 30677.

30400 (TID–25434) DIELECTRIC LOSS AND RADIATION DAMAGE IN RUTILE. Appendix A to Report Number 8. Johnson, O. W.; Myhra, Sverre; DeFord, J. W. (Utah Univ., Salt Lake City. Dept. of Physics). [nd]. Contract AT(11-1)-1434. 21p. Dep. CFSTI.

Dielectric loss spectra ($10^2 \leq f \leq 10^5$ Hz) for nominally pure stoichiometric rutile (TiO_2) are reported. Appropriate treatment of crystals is shown to reduce D to <0.01 over this frequency range at 27°C or to produce (reversibly) loss peaks ≥1.0. This behavior is shown to result from migration of donor defects due to electric fields induced by the presence of metal electrodes. Theoretical predictions are shown to agree well with observed behavior. Preliminary radiation damage studies using dielectric loss as a monitor of damage are described. (auth)

30401 TEMPERATURE DEPENDENCE OF THERMOMAGNETIC EFFECT IN Ni–W ALLOYS. Karshibaev, A. (Inst. of Physics and Tech., Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 6, 31-3(1969). (In Russian).

Thermomagnetic effects (thermal emf in a magnetic field) in Ni–W alloys were studied in a wide range of temperatures, especially at the temperatures close to the Curie point. (R.V.J.)

30402 NEUTRON-DIFFRACTION STUDY OF THE PSEUDOBINARY SYSTEM $ErCo_2$–$ErAl_2$. Oesterreicher, H.; Corliss, L. M.; Hastings, J. M. (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys.; 41: 2326-30(May 1970).

Results obtained by neutron diffraction indicate that the magnetic moment of the ferromagnetic sublattice in the Laves phase structures, C15 ($ErCo_2$, $ErAl_2$) and C14 (ErCoAl), varies with composition while the ordering temperatures stay approximately constant. Low values of the aligned moment, however, are accompanied by high values of the disorder scattering at low temperatures. Co carries no moment from 30 mole % $ErAl_2$ on. Results are discussed in terms of tendencies toward antiferromagnetism at certain values for the valence electron concentration. (auth)

30403 EFFECT OF PLASTIC DEFORMATION ON THE ANGULAR DISTRIBUTION OF PHOTONS DURING POSITRON ANNIHILATION IN A MOLYBDENUM CRYSTAL. Dekhtyar, I. Ya.; Mikhalenkov, V. S.; Sakharova, S. G. (Inst. of Metal Physics, Kiev). Sov. Phys.-Solid State (Engl. Transl.); 11: 2647-9(May 1970).

Translated from Fiz. Tverd. Tela; 11: 3266-9(Nov 1969).

The angular distribution of photons emitted during the annihilation of positrons and electrons has been studied for the (100) and (110) planes of molybdenum single crystals in deformed, polygonized, and annealed states. A change in the shape of the angular-

distribution curves has been found; it is qualitatively the same for polycrystalline materials, but is much more pronounced and differs for different planes. The results are related to the structural features of the molybdenum Fermi surface and to the change in the electron energy spectrum during deformation. (auth)

30404 EQUATION OF STATE OF GADOLINIUM NEAR THE CURIE POINT. Deschizeaux, Marie-Noel; Develey, Gerard (Institut Polytechnique, Grenoble, France). Compt. Rend., Ser. B; 270: 872-5(6 Apr 1970). (In French).

The variations of the magnetization of a gadolinium single crystal near the Curie temperature T_c were measured. The critical constants relating to spontaneous magnetization, magnetic susceptibility, and the critical isotherm were experimentally determined. An equation of state giving the transition around T_c is proposed. (France)

30405 DETERMINATION OF THE PARAMAGNETIC CORRECTION FACTOR OF YTTERBIUM. Herzog, P.; Lange, J.; Wagner, H. F. (Univ., Bonn). Z. Phys.; 234: 465-71(1970).

The Larmor precession of the first excited state of ^{172}Yb was measured by perturbed $\gamma-\gamma$ angular correlations in a liquid source at two different temperatures. By a comparison with the g-factor of this state directly obtained by other experiments, the corresponding paramagnetic correction factors were deduced to be $\beta(20°C) = 2.61 \pm 0.27$ and $\beta(33°C) = 2.43 \pm 0.27$. For the ions Sm^{3+}, Dy^{3+}, and Er^{3+} the paramagnetic correction factors have been calculated from experimental data given in literature. (auth)

30406 PHONON SCATTERING IN NH_4- AND ND_4Cl. Bausch, W. (Technische Hochschule, Darmstadt, Ger.). Z. Angew. Phys.; 29: 9-15(23 Apr 1970). (In German).

Results of measurements of the thermal conductivity of pure and x-irradiated NH_4Cl and ND_4Cl are presented for the temperature range 2 to 300°K. Librations of the NH_4-ions do not give an additional transport of heat and do not strongly scatter acoustical phonons. The results show clearly that there is a first-order phase transition in NH_4- and probably a second-order transition in ND_4Cl at about 242 and 249°K respectively. Resonant scattering of phonons is observed in $NH_4Cl:Tl$. X-irradiation at low temperatures yields a defect X which is not identical with the V_K and NH_3Cl centers known from ESR measurements. At higher temperatures, this defect X transforms to a defect Y, whose scattering cross section does not depend on phonon frequency. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 29553, 29555, and 29563.

30407 ELECTRON PARAMAGNETIC RESONANCE OF TRANSITION IONS. Abragam, A.; Bleaney, B. International Series of Monographs on Physics. New York; Oxford University Press (1970). 923p. $41.50.

This book gives the first comprehensive treatment of electron paramagnetic resonance of ions of the transition groups. An introductory survey gives a general understanding, and a general survey presents such topics as the classical and quantum resonance equations, the spin Hamiltonian, Endor, spin–spin and spin–lattice interactions, together with an outline of the known behavior of ions of each of the five transition groups, at the experimentalist's level. Finally, a theoretical survey, using group theory and symmetry properties, discusses the fundamentals of the theory of paramagnetism. A feature of the book is the inclusion of much hitherto unpublished material. Separate abstracts were prepared for two chapters—the lanthanide (4f) group and the actinide (5f) group. (TSS) (auth)

For abstracts of individual chapters see: 30408 and 30409.

30408 LANTHANIDE (4f) GROUP. pp 276-345 of Electron Paramagnetic Resonance of Transition Ions. /Abragam, A. (ed.). New York; Oxford University Press (1970).

Since lanthanides exhibit sharp lines in their optical spectra, much detailed information has been obtained for both ground and excited states by high-resolution spectroscopy. An extensive discussion of the spectroscopic properties is given by Wybourne (1965), much of which is relevant to the paramagnetic properties discussed in this chapter. Discussions are presented here under the following headings: lanthanide compounds; the free ions; crystalline field theory—C_{3h} symmetry; magnetic hyperfine structure; nuclear electric quadrupole interaction; experimental results for ethylsulfates and anhydrous chlorides; experimental results for the double nitrates, $Ln_2Mg_3(NO_3)_{12} \cdot 24H_2O$, lanthanide ions in cubic symmetry; ions with a half-filled 4f shell; and higher-order terms in the spin Hamiltonian. (L.M.T.)

30409 ACTINIDE (5f) GROUP. pp 346-64 of Electron Paramagnetic Resonance of Transition Ions. /Abragam, A. (ed.). New York; Oxford University Press (1970).

Results for this group are reviewed under the following headings: ions and compounds of the actinide group; tripositive actinide ions; actinide ions in CaF_2; actinide ions in octahedral symmetry; and neptunyl and plutonyl ions. (L.M.T.)

30410 STUDY OF THE Nb–Zr–H SYSTEM BY THE SPIN-ECHO METHOD. Khodosov, E. F.; Khodos, I. I. (Donetsk Physicotechnical Inst., Stalino, USSR). Sov. Phys.-Solid State (Engl. Transl.); 11: 2693-5(May 1970).

Translated from Fiz. Tverd. Tela; 11: 3325-8(Nov 1969).

Mixed hydrides of Nb–Fr were studied by the spin-echo method; the temperature dependence of the spin–lattice relaxation times T_1 and T_2 was measured over the range 20 to 200°C. The contributions from the diffusion mobility of the H atoms were found to be dominant, and from the second moments, the Zr–H interaction is negligible in comparison with the Nb–H dipole interaction. Analysis of the results shows that: the solubility of ZrH in NbH is between 5 and 13%; the diffusion barrier for H atoms diffusing in ZrH–NbH solid solutions is increased compared with NbH; the abrupt jumps in the T_1 and T_2 curves are explained by phase transitions; and the temperatures of the phase transitions in ZrH–NbH are higher than in NbH by ~12° in the single-phase region and by ~20° in the two-phase region. (D.L.C.)

30411 DIELECTRIC APPROACH TO ELECTRONIC ENERGY LOSS IN REAL SOLIDS UNDER CHANNELING CONDITIONS. Bonsignori, F.; Desalvo, A. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Lett. Nuovo Cim.; 1: 589-91(21 Apr 1969).

An outline of the fundamental features of a dielectric approach to electronic energy loss in real solids under channeling conditions is presented. (L.W.A.)

30412 SENSITIVITY OF NUCLEAR MAGNETIC DOUBLE RESONANCE. Spencer, Paul R.; Schmid, H. Dankward; Slichter, Charles P. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Phys. Rev., B; 1: 2989-3001(1 Apr 1970).

The dynamics of the nuclear magnetic double-resonance process for Na nuclei in a (2,0,0) position relative to a substitutional Ag^+ impurity in NaCl was studied for several Ag concentrations. The purpose was to determine experimentally the factors which limit the double-resonance sensitivity. For Ag concentrations below 0.03 mole %, the magnetization of unperturbed Na nuclei decayed exponentially with rates proportional to the impurity concentration when a rf field at the resonance frequency of the quadrupole-shifted transitions was applied. Using a method of intermittent search-field irradiation, evidence was found that the finite spin diffusion rate caused a double-resonance energy transfer rate under continuous search-field irradiation about 30% less than the transfer rate which would be observed if the spin diffusion were infinitely fast. A theoretical explanation of the results is given using a perturbation approach based on the concept of spin diffusion. In addition, the Na spin–lattice relaxation in the completely demagnetized state was studied as a function of impurity concentration, and a rapid initial decrease of spin order was found. This was caused by cross relaxation within the nuclear spin system. (auth)

Theoretical Physics

Refer also to abstracts 30542 and 30561.

30413 (LA-4214-TR) SCHROEDINGER INTEGRODIFFERENTIAL EQUATION. Talenti, Giorgio. Translated for Los Alamos Scientific Lab., N. Mex., from Rend. Sem. Mat. Univ. Padova, 38: 305-30(1967). 13p. Dep. CFSTI.

The author discusses the integro-differential equation $\Delta u(r) + k^2u(r) = \int_0^0 V(r,s)u(s)ds$ arising from the Schrödinger equation for a nonlocal potential, which is spherically symmetric. The nature of the solutions, for both bounded and scattering cases, is investigated for V such that $[\int_0^0(\int_0^0|V(r,s)|^p dr)^{q/p}ds]^{1/q} < \infty (1 < p < \infty; 1 \leq q \leq p/(p-1))$. A few results regarding the integrability of the solution with respect to r and its analyticity with respect to k are derived. (tr-auth)

30414 (SC-RR-69-739) AN IMPROVED CAPABILITY FOR SOLUTION OF PHOTON TRANSPORT PROBLEMS BY THE METHOD OF DISCRETE ORDINATES. Renken, James H.; Adams, Kenneth G. (Sandia Labs., Albuquerque, N. Mex.). Dec 1969. 195p. Dep. CFSTI.

A useful method for performing photon transport calculations is the method of discrete ordinates. For one-dimensional problems the formalism of this method was implemented by a com-

puter program called DTF-IV. This program was originally written at Los Alamos for the solution of neutron transport problems. A modified version of the original program was developed that is particularly convenient for the solution of photon transport problems. This new program is called DTF69. Modifications include provisions for external photon sources and the capability to treat secondary radiation such as fluorescence and positron annihilation photons. Presented here is the information necessary to use DTF69 for the solution of photon transport problems. (auth)

30415 ON THE QUANTUM THEORY OF VAVILOV–CHERENKOV RADIATION EMITTED BY AN ELECTRON IN A TRANSPARENT UNIAXIAL CRYSTAL. Kukanov, A. B. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 464-6(Nov 1969).

Translated from Opt. Spektrosk.; 27: 852-4(Nov 1969).

Previous work on the quantum corrections and electrodynamics of Cherenkov radiation is reviewed. Using perturbation theory methods, equations are derived for the intensity of Cherenkov radiation by an electron per unit path. Both cases where the electron moves along the optic axis of the crystal and perpendicular to the axis, are covered. (D.L.C.)

30416 NATURAL SPIN-ORBITALS AND GENERALIZED OVERLAP AMPLITUDES. Goscinski, O.; Lindner, P. (Quantum Chemistry Group for Research in Atomic, Molecular, and Solid-State Theory, Uppsala). J. Math. Phys. (N. Y.); 11: 1313-17(Apr 1970).

The generalized overlap amplitudes for "hole" states which appear in the one-particle Green's function are, in general, not linearly independent. It is shown that canonical orthonormalization of them yields the natural spin–orbitals (eigenfunctions of the first-order reduced density matrix). (auth)

30417 CLOSED-FORM IMPLICIT SUMMATION. Luger, A. D.; Robinson, E. J. (New York Univ., Bronx). Phys. Lett.; 31A: 247-8(9 Mar 1970).

The infinite sums that characterize perturbation theory may be evaluated implicitly via an inhomogeneous Schroedinger equation. It is shown that the solution to this equation may be expressed in closed form for problems involving time-dependent perturbations of hydrogenic systems. (auth)

30418 STOCHASTIC QUANTUM MECHANICS FOR PARTICLES WITH SPIN. De la Pena-Auerbach, L. (Univ. Nacional de Mexico, Mexico City). Phys. Lett.; 31A: 403-4(6 Apr 1970).

It is shown that a stochastic theory of quantum mechanics previously developed may be extended to cover the case of particles with integral or half-integral spin. A possible relativistic extension is discussed. (auth)

30419 PERTURBATIONAL ASPECTS OF THE LINEAR TRANSPORT EQUATION. Hejtmanek, H. (Univ. of Colorado, Boulder). J. Math. Anal. Appl.; 30: 237-45(May 1970).

The aim of this paper is to stimulate further work in the application of perturbation theorems to linear transport theory. The collision operator is a bounded perturbation to the collisionless transport operator, and this fact is used to study the semigroup generated by the transport operator and the perturbation of its spectrum. (auth)

30420 A NEW METHOD FOR THE SOLUTION OF THE SCHROEDINGER EQUATION. Canosa, Jose; Gomes de Oliveira, Roberto (IBM Scientific Center, Palo Alto, Calif.). J. Comput. Phys.; 5: 188-207(Apr 1970).

The potential in the one-dimensional Schroedinger equation is approximated by a step function with a finite number of steps. In each step, the resulting differential equation has constant coefficients and is integrated exactly in terms of circular or hyperbolic functions. The solutions are then matched at the interface of each layer to construct the eigenfunctions in the whole domain. Unique features of the numerical method are: (a) all the eigenfunctions and eigenvalues are obtained with the same absolute accuracy for the same number of steps in the potential; (b) any desired number of eigenvalues and eigenfunctions are obtained in one single pass without any need to supply initial guesses for the eigenvalues; (c) for any fixed number of steps in the potential, in principle, the whole infinite spectrum of eigenvalues and eigenfunctions is obtained. (auth)

30421 THE NUMERICAL SOLUTION OF SCHROEDINGER'S EQUATION WITH A NONLOCAL POTENTIAL. Grimm, R.; Storer, R. G. (Flinders Univ. of South Australia, Bedford Park). J. Comput. Phys.; 350-4(Apr 1970).

Previously, a new method was suggested for the numerical solution of Schroedinger's equation, based on an approximation for two noncommuting operators H_0 and H_1. Moreover, the error in making the replacement can be found from the evaluation of the expectation value of the next term. It is pointed out that this method also provides for a simple numerical solution of Schroedinger's equation with a nonlocal potential. (M.H.R.)

30422 EXACT DRIFT VELOCITY SOLUTIONS FOR CHARGED-PARTICLE MOTION IN A STATIC AXIALLY SYMMETRIC MAGNETIC FIELD. Seymour, P. W. (Univ. of Adelaide). Aust. J. Phys.; 23: 133-54(Apr 1970).

A static axially symmetric magnetic field possessing straight and parallel lines and having a radial field strength dependence of r^{-n} is considered, and exact drift velocity expressions are derived for bound electron motions occurring in the cases $n = 1$ and $n = 3$. In each case, the lower and upper limits, r_{min} and r_{max} of the electron's orbital motion are obtained, as well as the Alfvén drift velocity as an approximation in the small perturbation limit, in which the magnetic field changes by only a small fraction of itself over a gyroradius. In the case $n = 1$, the exact drift velocity characteristic attains a maximum, which implies that electrons of a particular transverse speed will drift faster than all others. In each case, the classical trajectory of the electron motion is completely specified by the polar coordinates r and θ, which are given in exact form in terms of an orbit parameter α, and conveniently approximated in the perturbation limit. Corresponding results for proton motion are readily obtained. (Australia)

30423 FUNCTIONAL FOKKER–PLANCK TREATMENT OF ELECTROMAGNETIC FIELD PROPAGATION IN A THERMAL MEDIUM. Graham, R.; Haken, H. (Univ., Stuttgart). Z. Phys.; 234: 193-206(1970).

The quantum statistics of continuous space time dependent electromagnetic fields is analyzed by means of functionals. The case of a field propagating in a thermal reservoir serves as a simple example to illustrate the succeeding steps: a master equation is derived for the density operator which is a functional of the field operators. By means of the coherent state representation for continuous fields, the master equation is transformed into a functional differential equation in the function space, spanned by the coherent state amplitudes. This equation is of the Fokker–Planck type and determines a Gaussian process for a continuum of variables or a field. It is solved by determining the characteristics in function space of the associated equation of motion for the characteristic functional and subsequent functional integration. The solution is used to calculate some correlation functions and the spectral function of the field. (auth)

30424 PHYSICAL INTERPRETATION OF SPACELIKE AND GHOSTLIKE SOLUTIONS OF INFINITE-MULTIPLET WAVE EQUATIONS. Barut, A. O. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 1: 601-4(21 Apr 1969).

An attempt is made to show that the ghostlike and spacelike solutions of the infinite-multiplet wave equations correspond to a simple and well-defined physical situation. A two-body problem is discussed. (L.W.A.)

30425 QUASI-CLASSICAL ASYMPTOTICS OF A POINT SOURCE FUNCTION FOR STATIONARY SCHROEDINGER EQUATION. Kucherenko, V. V. (Moscow State Univ.). Teor. Mat. Fiz.; 1: 384-406(Dec 1969). (In Russian).

Formulas are deduced for the uniform with respect to X quasi-classical asymptotics of the Green function of the stationary Schroedinger equation. The quasi-classical asymptotics proof for the Green functional is given, supposing the Newton equations with the potential V(x) (V(x)), being the smooth and rapidly decreasing function, not to possess finite orbits for the energy E. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 30467.

30426 (NEVIS-180) SEARCH FOR MASSIVE ELEMENTARY PARTICLES IN THE COSMIC RADIATION AT SEA LEVEL. Shulman, Seth (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). 1970. Contract AT(30-1)-1932. 100p. (R-705; CU-284). Dep. CFSTI.

Thesis.

An experiment was performed to search for massive elementary particles in the cosmic radiation at sea level. Velocity and range measurements provided a lower limit on the mass of particles traversing the apparatus. No events corresponding to a mass of about 2 BeV/c^2 or more were found in the velocity range $\beta = 0.55 - 0.8$. This result leads to an upper limit on the flux for this velocity range of 3.9×10^{-9} cm^{-2} sr^{-1} sec^{-1}. In order to interpret this flux limit in terms of a production cross section for strongly interacting massive particles, a model was developed for their production and propagation through the atmosphere. The results of this calculation, for wide variations in the model parameters, give a limit of $10-100 \times 10^{-30}$ cm^2 on the production cross section for strongly interacting particles with a mass in the range 10-15 proton masses. (auth)

Electromagnetic

30427 (CONF-690521-, pp 373-412) PRODUCTION OF VECTOR MESONS IN e^+-e^- COLLIDING BEAMS. Haissinski, J. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire).

A brief description is first given of electron-positron rings as sources of time-like virtual photons. The theoretical formalism for the treatment of vector meson production is discussed under the following topics: one-photon approximation and form factors; vector meson dominance model; parameterization of the form factors; pion form factor; and interference effects. Experiments performed at Novosibirsk and Orsay are described. The yield in $\pi^+\pi^-$ pairs at the ρ resonance was measured over the range of total center of mass energies of 580 to 1030 MeV. A search was made for possible $\rho-\omega$ interference effects in the ω resonance region. The yield in $\pi^+\pi^-\pi^0$ states was measured in a 60-MeV energy range covering the ω resonance and in a 15-MeV energy range covering the ϕ resonance. The yield in $K_S^0K_L^0$ pairs was also measured at the ϕ resonance energy by detecting the $\pi^+\pi^-$ decay mode of K_S^0. The experimental results are discussed and compared with theoretical predictions. (L.B.S.)

30428 (NEVIS-181) DALITZ PLOT ANALYSIS OF THE DECAYS OF $\eta \to \pi^+\pi^-\pi^0$ AND $\eta \to \pi^+\pi^-\gamma$. THE BRANCHING RATIO $\eta \to \pi^+\pi^-\gamma/\eta \to \pi^+\pi^-\pi^0$. Gormley, Michael (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). 1970. Contract AT(30-1)-1932. 97p. (R-706; CU-285). Dep. CFSTI.

We have measured the charge asymmetry in the decay $\eta \to \pi^+\pi^-\gamma$. From a sample of 7257 events, we find an asymmetry of $1.22 \pm 1.56\%$. The angular distribution is consistent with $J = 1$ for the dipion angular momentum. The measured γ-ray energy spectrum disagrees with the prediction of the simplest gauge invariant matrix element but is well represented by a simple ρ-dominant model. The Dalitz Plot distribution of 30,905 examples of $\eta \to \pi^+\pi^-\pi^0$ decay was fitted to a power series expansion of the matrix element. We find that a matrix element linear in the π^0 kinetic energy does not fit our data. We measure the branching ratio $\eta \to \pi^+\pi^-\gamma/\eta \to \pi^+\pi^-\pi^0$ to be 0.201 ± 0.006. (auth)

30429 PHOTOPRODUCTION OF ω MESONS FROM COMPLEX NUCLEI. Behrend, H.-J. (Univ. of Rochester, N. Y.); Lobkowicz, F.; Thorndike, E. H.; Wehmann, A. A.; Nordberg, M. E. Jr. Phys. Rev. Lett.; 24: 1246-51(1 Jun 1970).

Photoproduction of ω mesons from Be, C, Al, Cu, and Pb has been studied at a mean energy of 6.8 GeV. The t distributions show a forward peak characteristic of a coherent diffraction mechanism, but also a considerable cross section at large t characteristic of an incoherent production mechanism. The ratio of cross sections for coherently photoproduced ρ^0 mesons to ω mesons is 11.8 to 1.3 compared with the simple SU(3) prediction of 9. (auth)

30430 MAGNETIC MOMENT OF THE POSITVE MUON. Hutchinson, D. P. (Princeton-Pennsylvania Accelerator, Princeton, N. J.); Larsen, F. L.; Schoen, N. C.; Sober, D. I.; Kanofsky, A. S. Phys. Rev. Lett.; 24: 1254-6(1 Jun 1970).

The magnetic moment of the positive muon was measured relative to that of the proton by determining its precession frequency in a magnetic field measured by proton NMR. With both protons and muons bound in a spherical sample of water, the result is $\omega_{\mu'}/\omega_{p'} = 3.183{,}362 \pm 0.000{,}030$ (9.4 ppM). Including uncertainties due to the chemical environment of the muon, the result for free muons and protons is $\omega_\mu/\omega_p = 3.183{,}330 \pm 0.000{,}044$ (14 ppM) which is consistent with recent measurements of the hyperfine splitting of muonium. (auth)

30431 RADIATIVE CAPTURE OF DEUTERONS BY PROTONS. Belt, B. D.; Bingham, C. R.; Halbert, M. L.; van der Woude, A. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 24: 1120-3(18 May 1970).

The differential cross section for radiative capture of deuterons by protons has been measured by a novel method at deuteron energies near 20 and 30 MeV. The angular distributions are sufficiently detailed to show effects of transitions higher than quadrupole. The total cross sections, which are accurate to ±7%, are about 10% below recent theoretical calculations. (auth)

30432 MEASUREMENT OF $\gamma p\Delta(1236)$: VERTEX FORM FACTORS. Kajiura, N.; Baba, R.; Hamatsu, R.; Ishihara, N.; Kaneko, S. (Hiroshima Univ.). Genshikaku Kenkyu; 14: 135-44 (Nov 1969).

This is the preliminary report of the experiment recently performed with the external electron beam of the Tokyo 1.3-GeV Electron Synchrotron. Observation was made on the protons from decaying $\Delta^+(1236)$ in coincidence with scattered electrons. The decay protons were deflected and identified by observing their time-of-flight and energy loss. Electrons were detected with a total absorption Čerenkov counter. The result obtained can be summarized as follows: The scalar photon does not contribute to the production of $\Delta(1236)$. The $\gamma p\Delta(1236)$ vertex form factor seems to have similar dependence on momentum transfer to the proton form factor at least up to $q^2 = 8$ fm^{-2}. It is necessary to extend the measurement up to higher values of q^2 to examine the validity of the view suggested by Dufner and Tsai. (auth)

30433 PRELIMINARY RESULTS OF A NEW ELECTRON g-2 MEASUREMENT. Wesley, John C.; Rich, Arthur (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett.; 24: 1320-5(8 Jun 1970).

A new measurement of the electron g-factor anomaly is reported. The result is $a = (1{,}159{,}644 \pm 7) \times 10^{-9}$, in agreement with theory. (auth)

Weak

Refer also to abstracts 29566, 30489, and 30763.

30434 (CONF-690521-, pp 413-38) INFORMATION ON THE $\pi\pi$ INTERACTION FROM K_{e4} DECAYS AND $K_{\pi 2}^0$ DECAYS. Kalmus, George E. (California Univ., Berkeley. Lawrence Radiation Lab.).

A survey is given of the experimental information on K_{e4} and $K^0 \to 2\pi$ decays. Following a brief discussion on the theory of $K^+ \to \pi^+ + \pi^- + e^+ + \nu$ decays, the combined data from two heavy-liquid bubble chamber experiments are discussed. The values of the phase shifts $(\delta_s - \delta_p)$ average over the $\pi\pi$ mass plot obtained from the data are given, for constant form factors and for energy dependent form factors. Experimental results for the $\pi\pi$ phase shifts obtained from a larger amount of data on the $K^0 \to 2\pi$ decays are discussed. (L.B.S.)

30435 (N-70-18922) ANOMALOUS COMPONENT OF ATMOSPHERIC MUONS. Revised. Maeda, Kaichi (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan 1970. 11p. (NASA-TM-X-63740(Rev.); X-641-69-491(Rev.)). CFSTI.

An alternate interpretation of the recent underground muon data of Keuffel et al is presented. This new interpretation, which does not invoke an anomalous component of atmospheric muons produced by the so-called X-process, attempts to resolve discrepancies existing between the previous and the latest Utah results, as well as those with data from the underground experiments at Kolar. (auth)

30436 (NEVIS-179) A NEW MEASUREMENT OF THE LEPTONIC CHARGE ASYMMETRY IN K_{e3} DECAY. Marx, Jay (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.).

1970. Contract AT(30-1)-1932. 129p. (R-704; CU-283). Dep. CFSTI.

Thesis.

A new measurement of the leptonic charge asymmetry in K_{e3} decay has been performed at the Brookhaven AGS. The experiment yields a value of $(3.41 \pm 0.37) \times 10^{-3}$ for the asymmetry with the decay into positrons favored over the decay into electrons. The effects of accidentals and of the interactions of the K_L secondaries in the matter which makes up the detection apparatus account for the nonnegligible corrections applied to the raw measured asymmetry. The quoted uncertainty results from both statistical and systematic errors. A discussion of the effects of this measurement on both CP phenomenology and μ-e Universality is presented. (auth)

30437 MEASUREMENT OF MUON ENERGY IN THE ENERGY REGION ABOVE 10 TeV. Kitamura, Takashi; Wada, Tomonori (Osaka City Univ.). Uchusen Kenkyu; 14: 327-31(Oct 1969). (In Japanese).

A method was suggested to measure the muon energy above 10 TeV. This method was based on the direct pair production of electrons by a muon, the probability of which increases with incident muon energy $E\mu$. The basic calculation has been already given previously. The results of these calculations were discussed. The frequency of knock-on electrons can be neglected in comparison with the pair production for $E\mu$ above 1 TeV. This is shown with a graph. The statistical uncertainty in the determination of $E\mu$ is briefly discussed. An actual apparatus was proposed, which is composed of Pb producer layers and large-area proportional or scintillation counters. For $E\mu$ about 10 TeV, the Pb layer is 1 m in thickness, and 8 events in the pair frequency can be expected. The incident energy $E\mu$ is estimated from the number of pairs produced. The background due to bremsstrahlung photons was discussed, and the means to eliminate this effect was suggested. (auth)

30438 HUNTING FOR SOFT ANTINEUTRINOS. Marx, G.; Lux, I. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 28: 63-70(1970).

The individual detection of antineutrinos is discussed for the 0.1 to 1 MeV region. A practical possibility is offered by the antineutrino-induced K capture. With this method it seems possible to measure the total quantity of different radioactive elements in the earth. The number of ^{40}K atoms may be obtained e.g. by counting the antineutrino-induced K captures on the otherwise stable ^{112}Sn atoms. (auth)

Strong (Baryon-Induced)

Refer also to abstract 30466.

30439 (CONF-690521-, pp 326-36) PRODUCTION OF ω IN THE REACTION $p + d \rightarrow {}^3He + \omega^0$ USING A NOVEL MISSING-MASS SPECTROMETER. Brody, H.; Groves, E.; VanBerg, R.; Wales, W. (Pennsylvania Univ., Philadelphia); Maglic, B.; Norem, J. (Rutgers-The State Univ., New Brunswick, N. J.); Schluter, R. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.); Cvijanovich, G. (Uppsala Univ. (Sweden)).

A new type missing-mass spectrometer in use at the Princeton-Pennsylvania Accelerator is reported, and some preliminary data on the reaction $p + d \rightarrow {}^3He + \omega^0$ at 3 GeV are shown. (L.B.S.)

30440 (LA-4274) TARGET-TO-DETECTOR TRANSPORT CODE FOR LOW-ENERGY p-p VACUUM POLARIZATION AND BREMSSTRAHLUNG EXPERIMENTS. Johnson, J. D.; Porter, L. E.; Brolley, J. E. (Los Alamos Scientific Lab., N. Mex.). Sep 1969. Contract W-7405-eng-36. 147p. Dep. CFSTI.

A particle transport computer code called DIVLENS is described in detail. The main program selects particles at random from a beam-illuminated target volume and follows them through a spherical electrostatic lens to detectors. One group of subroutines obtains the lens electrostatic potential, whereas a second group calculates the energies of inelastically scattered particles. Complete listings, flow charts, and input-output synopses are included. (auth)

30441 (UCRL-19705) MEASUREMENT OF NP (PP) TRIPLE SCATTERING PARAMETERS $R^t(R)$ AND $R'^t(R')$ 510 TO 670 MeV. Leung, Kwok-Chu (California Univ., Berkeley. Lawrence Radiation Lab.). 12 Mar 1970. Contract W-7405-eng-48. 55p. Dep. CFSTI.

Thesis.

Wolfenstein triple scattering parameters R and R' for the proton–proton system and R^t and R'^t for the neutron–proton system were measured. The p–p data were measured at three angles at 510, 600, and 670 MeV, and the n–p data were measured at four angles at 510 and 600 MeV. No strong energy dependence is observed in either case. A spark chamber spectrometer system was used to analyze the second and third scattering. Polarized proton and neutron beams were produced by scattering the primary proton beam off liquid hydrogen and liquid deuteron targets respectively. Good agreement is found between the proton–proton data and the published data at 430 and 660 MeV. Phase shift predictions are compared to the results. (auth)

30442 I = 1 ENHANCEMENT NEAR 2360 MeV OBSERVED IN $\bar{N}N$ KAON ANNIHILATION CROSS SECTIONS. Oh, B. Y.; Parker, D. L.; Eastman, P. S.; Smith, G. A.; Sprafka, R. J.; Ma, Z. M. (Michigan State Univ., East Lansing). Phys. Rev. Lett.; 24: 1257-60(1 Jun 1970).

A significant isospin-1 enhancement in the cross sections for $\bar{p}p$ $(\bar{p}n) \rightarrow K^*(890)\bar{K}\pi\pi$ $(\bar{K}^*K\pi\pi)$ is observed at a mass of 2360 ± 25 MeV with a width $\Gamma < 60$ MeV. This mass and width are consistent with the U meson and an enhancement reported in a recent Brookhaven National Laboratory backward π^-p missing-mass experiment. Whereas the data agree with the Brookhaven National Laboratory $\bar{N}N$ total cross section measurements on the $\pi_1^*(2350)$ position, the width is clearly inconsistent with their value of 140 MeV. (auth)

30443 INVESTIGATION OF PARITY NONCONSERVATION IN THE REACTION $n + p \rightarrow d + \gamma$. Lobashov, V. M.; Egorov, A. E.; Kaminker, D. M.; Nazarenko, V. A.; Saenko, L. F.; Smotritskii, L. M.; Kharkevich, G. I.; Knyaz'kov, V. A. ZETP Lett. (USSR)(Engl. Transl.); 11: 76-9(20 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 124-8 (20 Jan 1970).

The preliminary results of an experiment for the measurement of the circular polarization of gamma quanta in radiative capture of thermal neutrons in hydrogen are presented. (J.F.P.)

30444 EFFECTIVE CROSS SECTIONS OF INELASTIC PROTON INTERACTION WITH CARBON AND HYDROGEN NUCLEI IN THE ENERGY REGION 20 TO 600 GeV MEASURED AT THE SPACE STATIONS "PROTON-1", "PROTON-2", AND "PROTON-3". Grigorov, N. L.; Nesterov, V. E.; Rapoport, I. D.; Savenko, I. A.; Skuridin, G. A. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 11: 814-29(Apr 1970). (In Russian).

Cross sections σ_{pC}^{in} and σ_{pp}^{in} at the effective proton energies from 20 up to 600 GeV are measured by means of a set-up stated on the space stations "Proton-1, 2, 3." With the proton energy rise from 20 up to 600 GeV the cross section σ_{pC}^{in} increased by (20 ± 5)%. The cross section σ_{pp}^{in} is obtained by the difference (polyethylene–carbon) method with errors 8–20%. The measured dependence of σ_{pp}^{in} on the energy does not contradict to the observed increase of the cross section σ_{pC}^{in} in the same energy range. Analysis is carried out of various methodic effects and of trivial physical processes that influence the value of the measured cross sections. It is shown that one cannot explain the observed increase of the cross section with these effects. (auth)

30445 EVIDENCE FOR HEAVY-PARTICLE PRODUCTION PROCESSES AT ENERGIES ABOVE 2×10^{11} eV. Kaufman, Leon (Bellcomm, Inc., Washington, D. C.); Mongan, Thomas R. Phys. Rev., D; 1: 988-97(15 Feb 1970).

Cosmic-ray flux measurements in the energy region 10^{10} to 10^{14} eV obtained by calorimeters on the satellites Proton I and II have shown results that are at variance with previous data. While a single power law provides an approximate fit to the all-particle spectrum, the primary proton flux falls sharply at energies above $\sim 5 \times 10^{11}$ eV, indicating that at high energies protons become progressively scarcer in the primary flux. The cross section for particle production by protons on carbon is found to rise by 20% in the interval between 2×10^{10} and 10^{12} eV. Assuming that, in the energy region of interest, (1) the real proton flux is given by a single power law, and (2) the nuclear composition remains constant, it is shown that the satellite flux measurements can be explained by an energy-loss mechanism in the calorimeter, the loss being a function of the energy per nucleon rather than the total energy. Furthermore, this "X" process has a cross section of the right magnitude to account for the p-carbon cross-section measurements. The X process could be described in terms of particle production or dissociation of the primary protons. (auth)

30446 NEUTRON–PROTON TOTAL CROSS-SECTIONS BETWEEN 8 GeVc AND 21 GeVc. Engler, J. (Institut fuer Experimentelle Kernphysik, Karlsruhe, Ger.); Horn, K.; Moennig, F.; (and others). Phys. Lett., 31B: 669-72(11 May 1970).

Neutron-proton total cross-sections were measured in the momentum range from 8 GeV/c to 21 GeV/c with an accuracy of better than 2% using a 0° neutron beam at the CERN Proton Synchrotron. The np total cross section drops from 39.7 mb at 8 GeV/c to 38.5 mb at 21 GeV/c, and thus follows closely the pp total cross sections in this momentum interval. (auth)

30447 POSSIBILITY OF EXPERIMENTAL INVESTIGATION OF THE EFFECTIVE RADIUS OF STRONG INTERACTIONS. Logunov, A. A.; Nguyen Van Hieu. Teor. Mat. Fiz.; 1: 375-7 (Dec 1969). (In Russian).

It is shown that experimental tests of the diffraction peak of elastic and nonelastic processes provide a possibility to estimate lower bounds of the effective radius of strong interactions. (auth)

Strong (Meson-Induced)

Refer also to abstracts 30502 and 30521.

30448 (CONF-690521-, pp 55-74) LOW ENERGY $\pi\pi$ PHASE SHIFTS FROM COULOMB INTERFERENCE. Biswas, N. N. (Notre Dame Univ., Ind.).

The possibility of evaluating the $\pi\pi$ phase shifts in the low mass region from $\pi N \to \pi\pi B$ processes using interference with the Coulomb amplitude is investigated. Assuming that the $\pi N \to \pi\pi B$ interaction is dominated by one-pion-exchange, the method utilizes the $\cos\theta$ distributions for low $\pi\pi$ masses, where θ is the scattering angle in the $\pi\pi$ cm system. The Coulomb contributions to the $\pi^+\pi^\pm$ and $\pi^-\pi^+$ angular distributions in the forward direction are comparable to the nuclear contribution and the interference of these amplitudes produces observable effects. From the knowledge of the Coulomb amplitude, the $\pi\pi$ nuclear amplitude can be determined in both sign and magnitude. This technique is applied to available bubble-chamber data to determine I = 2 and I = 0 s-wave $\pi\pi$ phase shift. The results were found consistent with those obtained from other methods in the mass region where the data overlap. (L.B.S.)

30449 (CONF-690521-, pp 131-48) DETERMINATION OF δ_0^2 FROM CHEW-LOW EXTRAPOLATION AND RESONANCE t DEPENDENCE. Baton, J. P.; Laurens, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Some results are presented of an analysis of $\pi\pi$ phase shifts from a Chew-Low extrapolation of $\pi^-p \to p\pi^-\pi^0$ data from the physical region. Comments are made on the results and on their consequences. (L.B.S.)

30450 (CONF-690521-, pp 179-216) STUDY OF 2 π^0 PRODUCTION BELOW 1 GeV AND DETERMINATION OF THE SIGN OF δ_0 AT LOW $\pi\pi$ MASS. Cline, D. (Wisconsin Univ., Madison. Hawaii Univ., Honolulu); Braun, K. J.; Scherer, V. R. (Wisconsin Univ., Madison).

Using the reaction $\pi^+d \to p(p)(mm)$ at 2.15 BeV/c with gamma rays from the final state π^0's being detected in Ta plates, a 2 π^0 mass spectrum was obtained in several ways. The resulting cross section for 2 π^0 production is in good agreement with the predictions of the OPE model. The 2 π^0 mass spectrum is not appreciably different from phase space and favors the down-down $\pi\pi$ phase shift solutions suggesting a very broad ϵ. A new method of determining certain low energy $\pi\pi$ scattering parameters using ratios of cross sections is suggested. Using this method the low energy T = 0, I = 0 $\pi\pi$ scattering phase shift is found to be almost certainly positive. (auth)

30451 (CONF-690521-, pp 217-40) A RESUME OF DATA ON THE REACTION $\pi^-\pi^+ \to \pi^0\pi^0$. Walker, W. D. (Wisconsin Univ., Madison).

Experimental studies of the $\pi\pi$ phase shifts in the ρ mass region from $\pi^-\pi^+ \to \pi^0\pi^0$ interactions are briefly surveyed. (L.B.S.)

30452 (CONF-690521-, pp 285-99) STRUCTURE IN THE $\pi^+\pi^-$ SYSTEM AT 480 MeV. Dubal, Leo (Geneva Univ. (Switzerland). European Organization for Nuclear Research, Geneva (Switzerland)); Roos, Matts (European Organization for Nuclear Research, Geneva (Switzerland)).

A 25 μb enhancement (5.2 standard deviations) in a compiled $\pi^+\pi^-$ mass distribution from $\pi^-p \to \pi^+\pi^-n$ is studied. Failing to explain it as an effect of misidentification (accidental kinematic misfits), it is proposed that it is due to an I = 0 resonance, decaying strongly or electromagnetically. For the strong decay a particular model is studied which fits the mass distribution well. The mass of the resonance is 482 ± 3 MeV and the width $\lesssim$25 MeV. In our particular strong decay model the width is 9 MeV. Experimental arguments render the electromagnetic decay less likely. (auth)

30453 (CONF-690521-, pp 316-25) INFORMATION ON THE I = J = 0 $\pi\pi$ PHASE SHIFT FROM SINGLE PION PRODUCTION AT LOW ENERGIES. Saxon, David H.; Mulvey, John H. (Oxford Univ. (England). Dept. of Nuclear Physics); Chinowsky, W. (California Univ., Berkeley. Lawrence Radiation Lab.).

Some results from the analysis of the reaction $\pi^-p \to \pi\pi N$ at low incident π^- momenta are presented. The high-mass $\pi\pi$ enhancement (Kirz anomaly) can be explained in terms of I = J = 0 dipion production, with particular forms for the dependence of δ_{00} on $M_{\pi\pi}$. It is not necessary to invoke a low-mass dipion resonance. (auth)

30454 (CONF-690521-, pp 337-8) THE $\pi\pi$ PHASE SHIFT $\delta_0 - \delta_0$ FROM A NEW MEASUREMENT OF THE K_s BRANCHING RATIO. Morfin, Jorge G.; Sinclair, Daniel (Michigan Univ., Ann Arbor).

The branching ratio for $R = \Gamma(K_s \to \pi^+\pi^-)/\Gamma(K_s \to \pi^0\pi^0)$ was found to be 2.10 ± .06 from measurements of approximately 25,000 charge exchange reactions of K^+ mesons in a heavy liquid bubble chamber. A search was made for either a $\pi^+\pi^-$ decay of K_2^0 or one or more electron pairs from the decay of a π^0. From the value of R the $\pi\pi$ phase shift $\delta_2 - \delta_0$ was determined to be 74° ± 10°. (L.B.S.)

30455 (CONF-690521-, pp 339-51) ANALYSIS OF $\pi^-\pi^+$ SCATTERING IN $\pi^+p \to \pi^-\pi^+\pi^+p$ INTERACTIONS. Malamud, Ernest; Schlein, Peter E.; Trippe, T. G. (California Univ., Los Angeles); Brown, D.; Gidal, G. (California Univ., Berkeley. Lawrence Radiation Lab.).

Approximately 19,000 events of the type $\pi^+p \to \pi^-\pi^+\pi^+p$ produced at pion momenta ranging from 3.2 GeV/c to 8.4 GeV/c were compiled from various groups. The data are dominated by the well-known peripheral ρN^{*++} production. An analysis of the $\pi\pi$ scattering was performed, yielding values for the T = 0 s-wave phase shift in agreement with those recently obtained in an analysis of $\pi^-p \to \pi^-\pi^+n$. The results reinforce the earlier conclusions that there exists a T = 0 scalar meson $\sigma(730)$. (auth)

30456 (CONF-690521-, pp 446-76) EXPERIMENTAL STUDIES OF THE Kπ INTERACTION. Schlein, Peter E. (California Univ., Los Angeles).

A review is given of some general features of the Kπ interaction and the reactions which can be studied. The essential features of the UCLA analysis and results for the $K^+p \to K^+(K^0)\pi^-(\pi^0)\Delta^{++}$ interaction at 7.3 GeV/c are discussed. Other recent work and problems discussed are concerned with the T = $^3/_2$ interaction, Reggeized–Deck model, and measurement of the low-energy $K^-\pi^-$ cross section. (L.B.S.)

30457 (CONF-690521-, pp 520-8) $K^-\pi^+$ SYSTEM ASSOCIATED WITH THE Q ENHANCEMENT FROM $K^-d \to K^-\pi^+\pi^-d$ AT 5.5 GeV/c. Wangler, Tom (Argonne National Lab., Ill.).

Bubble-chamber data from an Argonne–Northwestern collaboration showed that the reaction $K^-d \to K^-\pi^+\pi^-d$ at 5.5 GeV/c is dominated by the production of the Q enhancement of the K$\pi\pi$ system from 1.1 to about 1.5 GeV. Comparison of the Kπ angular correlations in the Q reaction with those observed in reactions believed to be dominated by Kπ scattering show a similarity of the moments which is explained by the Deck mechanism. It is concluded that a 1^+ K$\pi\pi$ system with a p-wave Kπ final state interaction and a 0^- K$\pi\pi$ system with an s-wave Kπ final state interaction are observed. (L.B.S.)

30458 (CONF-690521-, pp 529-32) STUDY OF K^+K^- PAIRS FROM THE REACTION $\pi^-p \to K^+K^-n$ AT 11 GeV/c. Dietl, H.; Koch, W.; Lorenz, E.; Luetjens, G.; Stierlin, U.; Von Lindern, L.; Weilhammer, P. (Max-Planck-Institut fuer Physik, Munich (West Germany)); Hyams, B. D.; Potter, D. (European Organization for Nuclear Research, Geneva (Switzerland)).

Preliminary results of an experiment on $\pi^-p \to K^+K^-n$ at 11 GeV/c are reported. The experiment was performed at the CERN proton synchrotron using optical spark chambers and a gas-Cherenkov counter filled with freon. Two peaks are observed in the K^+K^- mass spectrum—one at a mass of 1018.7 MeV/c^2, which is identified with the ϕ meson; and the second at a mass of 1063 MeV/c^2 with a width of Γ = 4 ± 2 MeV/c^2. (L.B.S.)

30459 (INP-694) SOME INTERACTIONS OF π^- MESONS WITH NUCLEAR EMULSION AT 60 GeV/c. Rybicki, Krzysztof (Institute of Nuclear Research, Krakow (Poland)). 1969. 106p. (In Polish). Dep. CFSTI (U. S. Sales Only).

Inelastic π^--proton interactions and coherent production of particles on emulsion nuclei by 60 GeV/c pions were studied. The results obtained were compared with the data on the interactions of accelerator pions of the momenta up to 25 GeV/c as well as with the results concerning the interactions of cosmic-ray pions at the average energy of about 200 GeV. The average multiplicity of 574 π^--p events studied in this work is 6.64 ± 0.16. It was found that the majority of secondary particles are emitted into the forward hemisphere in the π-proton cm system. As the multiplicity increases the angular distribution of secondaries becomes less asymmetric though it remains an anisotropic one. The number of the coherent-production events was estimated on the basis of the multiplicity distribution as well as with the help of the $\Sigma \sin\vartheta_i$ parameter for these collisions in which neither distribution nor visible recoil nor excitation of the target nucleus

was observed. $\lambda_3 = (16.5^{+}_{-}{}^{3}_{2})$m and $\lambda_5 = (133^{+}_{-}{}^{68}_{32})$m were obtained as the interaction lengths for the coherent production of three and five charged pions, respectively, on emulsion nuclei at 60 GeV/c. Comparing these results to those at other energies an increase of the cross section for the coherent production with increasing energy was observed. This increase is probably due to the opening of the new coherent-production channels. (auth)

30460 (UCRL-19359(Add.)) K^--NEUTRON ELASTIC SCATTERING FROM $K^-d \rightarrow K^-d$ AND $K^-d \rightarrow K^-pn$ AT 1 GeV/c. Jew, Nathan Nay Shew (California Univ., Berkeley. Lawrence Radiation Lab.). Apr 1970. Contract W-7405-eng-48. 7p. Dep. CFSTI.

An extension of a previous analysis of $K^- + N$ elastic scattering from $K^- + d \rightarrow K^- + d$ and $K^- + d \rightarrow K^- + p + n$ at 1 GeV/c. It is noted that as in the previous analysis the fits at 910 MeV/c are generally bad, but those at other momenta are generally better. (J.F.P.)

30461 OBSERVATION OF N*(1720) DECAY TO $\Delta(1236)\pi$ FROM π^+p INTERACTIONS AT 13.1 GeV. Willmann, R. B.; Lamsa, J. W.; Gaidos, J. A.; Ezell, C. R. (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett.; 24: 1260-4(1 Jun 1970).

Evidence is presented for the production of N*(1720) (M = 1719 ± 6 MeV, Γ = 63 ± 12 MeV) and subsequent decay to $\Delta(1236)\pi$ in π^+p interactions at 13.1 GeV. Analysis of the sequential decay $N^*(1720) \rightarrow \Delta^{++}\pi^- \rightarrow p\pi^+\pi^-$ limits the spin to values greater than $^3/_2$. (auth)

30462 HIGH-ENERGY PROTONS FROM ABSORPTION OF MUONS BY EMULSION NUCLEI. Vaisenberg, A. O.; Kolganova, E. D.; Rabin, N. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 830-9(Apr 1970). (In Russian).

The spectrum is investigated of protons with energies ≥25 MeV, emitted from heavy nuclei of emulsion Ag, Br in the absorption of stopped negative muons. It is shown that the numbers of fast secondary protons per an absorption act are $(3.16 \pm 0.34)\ (10)^{-4}$ and $(4.7 \pm 1.1)\ (10)^{-5}$ for the proton energies higher than 25 and 40 MeV, respectively. Background from the pion stars was carefully analyzed. The background from one-prong pion stars with protons of energies $E_p \geq 25$ MeV and $E_p \geq 40$ MeV is no more than 8 and 30%, respectively. (auth)

30463 INVESTIGATION OF CHANNELS OF THE REACTION $\pi^+ + p \rightarrow p + \pi^+ + m\gamma$ AT 2.9 GeV/c. Baldin, A. B.; Ergakov, V. A.; Trebukhovskii, Yu. V.; Shishov, N. N. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 800-4(Apr 1970). (In Russian).

Channels of the reaction $\pi^+ + p \rightarrow p + \pi^+ + m\gamma$ (1) were investigated by means of a 120-l propane-xenon bubble chamber exposed to the 2.9-GeV/c π^+-meson beam. On 150000 photographs 2670 events of the reaction with the proton momentum p_p from 0.2 up to 0.6 – 0.8 GeV/c and 1717 events with $p_p > 0.6 - 0.8$ GeV/c were studied. Branching ratios for the reactions (1) with different numbers of the γ quanta, 2γ, $(3-4)\gamma$, $(5-6)\gamma$, and $(7-8)\gamma$, are given: $(0.655 \pm 0.020) : (0.256 \pm 0.012) : (0.072 \pm 0.010) : (0.017 \pm 0.010)$. Cross sections of the reactions $\pi^+ + p \rightarrow p + \pi^+ + m\pi^0$ with $m \geq 1$, are estimated: $\sigma_{p\pi^+\pi^0} = 4.9 \pm 0.25$ mb, $\sigma_{p\pi^+2\pi^0} = 1.85 \pm 0.13$ mb, $\sigma_{p\pi^+3\pi^0} = 0.58 \pm 0.10$ mb, $\sigma_{p\pi^+4\pi^0} = 0.14 \pm 0.08$ mb. (auth)

30464 INVESTIGATION OF SPIN AND PARITY OF THE B MESON. Erofeev, I. A.; Vetlitskii, I. A.; Vladimirskii, V. V.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 805-9(Apr 1970). (In Russian).

Analyzing angular distributions in the cascade decay $B^- \rightarrow \pi^-\omega^0$, $\omega^0 \rightarrow \pi^+\pi^-\pi^0$, the B meson is found to have J^P either 1^+, or 2^+, 3^-, ... Comparison with the data of previous work makes the quantum numbers 1^+ more plausible. (auth)

30465 OBSERVATION OF THE INTERFERENCE BETWEEN K_L^0 AND K_S^0 IN THE $\pi^0\pi^0$ DECAY MODE. Chollet, J. C.; Gaillard, J.-M.; Jane, M. R.; Ratcliffe, T. J.; Repellin, J.-P.; Schubert, K. R.; Wolff, B. (CERN, Geneva). Phys. Lett., 31B: 658-61 (11 May 1970).

Data obtained with a copper regenerator on the interference between the decays $K_L^0 \rightarrow 2\pi^0$ and $K_S^0 \rightarrow 2\pi^0$ are presented. The analysis leads to the results: $\phi_{00} = 51° \pm 30°$, $|\eta_{00}| = (1.23 \pm 0.24)\ (|f - \bar{f}|/k_0) \times 10^{-3}$, where $(f - \bar{f})/k_0$ is the regeneration amplitude for copper at 2 GeV/c in fm². Present experimental data suggest $|f - \bar{f}|/k_0 = 2.7 \pm 0.3$. (auth)

30466 MEASUREMENTS OF K_L^0 AND NEUTRON TOTAL CROSS SECTIONS ON NUCLEI AT GeV ENERGIES. Lakin, W. L.; Hughes, E. B.; O'Neill, L. H.; Otis, J. N.; Mandansky, L. (Stanford Univ., Calif.). Phys. Lett., 31B: 677-81(11 May 1970).

Measurements of K_L^0 and neutron total cross sections are reported for C, Al, Cu, and Pb at average momenta of 9.0 GeV/c for K_L^0 and 3.8 GeV/c for neutrons. Comparison is made with the predictions of an optical model calculation. (auth)

Particle Interactions and Properties (Theoretical)

General

30467 (BMBW-FBK-70-3) ANNUAL REPORT, 1968. (Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Feb 1970. 79p. (In German). Dep. CFSTI (U. S. Sales Only). ZAED DM 16.60.

Research at Physikalisches Staatsinstitut–II. Institut für Experimentalphysik, Hamburg–Bahrenfeld, includes experimental and theoretical studies in the fields of nuclear and high energy physics. Concerning nuclear physics investigations stress is laid mainly on nuclear spectroscopy and the study of nuclear reactions. These experiments are performed with a 3 MeV van de Graaff generator and by means of radioactive sources. High energy physics is investigated especially by analysis of photographs taken in the bubble chambers and by studies of production processes of elementary particles, both in connection with Deutsches Elektronen-Synchrotron (DESY). (auth)

30468 SIMPLE MODEL FOR TACHYONS. Ben-Abraham, Shelomo I. (Instituto Tecnologico de Aeronautica, Sao Paulo, Brazil). Phys. Rev. Lett.; 24: 1245-6(1 Jun 1970).

The Frenkel–Kontorova model of a dislocation might be useful for the study of tachyons. The model has tachyonlike solutions which correspond to unstable states. This may explain why tachyons are unlikely to be observed. (auth)

30469 SOME PREDICTIONS FOR POLARIZATION OF FINITE PARTICLES IN ELASTIC AND INELASTIC PROCESSES AT HIGH ENERGIES. Kudryavtsev, V. A.; Levin, E. M.; Shchipakin, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 11: 858-69(Apr 1970). (In Russian).

Polarization properties of finite particles in the elastic and inelastic processes at high energies and due to the contribution from vacuum branch points and from conspiring Regge poles are briefly discussed. (auth)

30470 SEARCH FOR NEW STABLE PARTICLES. Pontekorvo, B. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 846-51(Apr 1970). (In Russian).

A new method is proposed for searching for new "stable" particles with decay time more than 10^{-8} sec. The new method is applicable when the particle is attracted to nuclei. It is then suggested to search for the "radioactivity" of a quasi-nucleus produced in nucleon collisions with nuclei and consisting of a nucleus in which the new particle is bound. The method allows, in principle, the observation of both neutral and charged particles produced with very small cross sections ($>10^{-40}$ cm²). (auth)

30471 TOPOLOGICAL-COVARIANT FORMULATION OF THE ANGULAR MOMENTA THEORY. Shelepin, L. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 11: 912-19(Apr 1970). (In Russian).

The connection between the angular momenta theory and topological properties of many-dimensional spaces is established. Uniform writing is introduced and formulas for j symbols are simplified. The rule for enumerating of j symbols which is reduced to writing of generalized treelike graphs is given. New symbols are introduced which give the transition between different associations of Racah coefficients. Some physical aspects of applying topological methods are discussed. (auth)

30472 ANOMALOUS HEADLIGHT EFFECT. Schey, Harry M. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 1: 1029-34(15 Feb 1970).

The headlight effect was investigated for nonelectromagnetic radiation, and it was found that, depending upon the wave and source velocities, the effect may be normal (radiation concentrated in the forward direction) or anomalous (radiation concentrated in some direction other than forward). Expressions are derived for the distribution of the radiation as a function of angle for both an infinite line source and a point source, and the critical wave velocity at which the headlight effect makes a transition from anomalous to normal is determined for both cases as a function of source velocity. A possible application to the decay of radioactive particles is suggested. (auth)

30473 THEORY OF HIGH-ENERGY DIFFRACTION SCATTERING. II. Cheng, Hung (Massachusetts Inst. of Tech.,

Cambridge); Wu, Tai Tsun. Phys. Rev., D; 1: 1083-91(15 Feb 1970).

The treatment in Paper I of this series is extended by studying high-energy scattering processes from the viewpoint of the projectile system, i.e., the system in which the incident particle is at rest. In particular, two equivalent sets of rules for obtaining the high-energy scattering amplitudes are given from this standpoint, one for the momentum space and the other for the position space. It is found that both sets of rules give directly the exact expression of the impact factor, and no more approximations need to be made even for the numerators of the integrals involved. It is concluded that the impact factor is best studied in the projectile system, while the potential is most conveniently taken care of in the laboratory system, and that they can be separately treated. In the case of high-energy collision of two particles, each impact factor is best studied in its own projectile system. These two sets of rules are shown to be equivalent to those in the laboratory system. In the Appendix high-energy scattering processes in the position space are also studied from the viewpoint of the laboratory system, and explicit rules are given. (auth)

30474 LORENTZ-INVARIANT LOCALIZATION FOR ELEMENTARY SYSTEMS. II. Kalnay, A. J. (International Centre for Theoretical Physics, Trieste, Italy. Univ. Nacional de Ingenieria, Lima). Phys. Rev., D; 1: 1092-1104(15 Feb 1970).

An attempt is made to find to what extent the notion of position in the relativistic quantum mechanics of free elementary systems of nonzero mass is defined (or precluded) by the requirement that the descriptions of a localized state as seen from two observers in different frames of reference should be physically consistent. Neither the existence of a time component of the position operator nor the compatibility of the space components of position is assumed. Hermiticity with respect to the quantum-relativistic scalar product in state-vector space is neither assumed nor rejected. There are three possibilities: (i) The position is represented as usual by a Hermitian operator; this is the point-type position. (ii) Non-Hermitian operators are accepted, and the k component of position can represent segments of the k axis with length of the order of $1/m$; when the operator is not only non-Hermitian, but also non-normal, this is the extended-type position. (iii) Non-Hermitian operators are accepted, but the segments are reduced to points; this is the limiting case of the extended-type position. Case (ii) is not studied in this paper. General conditions are found for any spin as regards cases (i) and (iii), and their consequences are obtained for spin 0 and spin $\frac{1}{2}$. The results are the following: There is no position operator in case (i), but in case (iii) the position operator is unique for spin 0 and unique up to a parameter for spin $\frac{1}{2}$. For both spins, in spite of the lack of relativistic Hermiticity, the eigenvalues of position are real, and the velocity is the expected one. The eigenstates of one component of the position are found. The components of the position are compatible with each other for spin 0, and incompatible for spin $\frac{1}{2}$. In the former case, the simultaneous eigenstates of all components are Philips's class-I localized states. Related work is discussed. (auth)

30475 CLASS OF REPRESENTATIONS OF CURRENT ALGEBRA. Klimyk, A. U. (Inst. of Theoretical Physics, Kiev). Teor. Mat. Fiz.; 1: 318-28(Dec 1969). (In Russian).

The linear representations of current commutation relations in a direct integral of Hilbert spaces by bounded operaters are considered. (auth)

Electromagnetic

Refer also to abstracts 30427, 30556, and 30953.

30476 (CONF-690521-, pp 439-45) PHOTOPRODUCTION OF $J^P = 0^+$ DIPION. Rosen, Jerome (Rochester Univ., N. Y.).

The coherent photoproduction of the 750 MeV 0^+ dipion in the Coulomb field of a nucleus is discussed. The amplitude for such a process is expected to interfere with the well established process of coherent ρ^0 photoproduction. The possible relevance to recently reported data is noted. (auth)

30477 (LNF-70/7) VECTOR DOMINANCE MODEL AND INFINITE MULTIPLETS. Note No. 466. Ferrara, S.; Grillo, A. F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 4 Mar 1970. 8p. Dep. CFSTI (U. S. Sales Only).

A possible interpretation of hadron Veneziano-like electromagnetic form factors in the framework of the field theory of composite systems is given. A phenomenological propagator, which contains an infinite sequence of poles, is written, and then vertex functions are computed as matrix elements of a vector operator between numbers of an infinite multiplet of some noncompact graph. (J.F.P.)

30478 (N-69-10274) FOUR PHOTON ANNIHILATION OF AN ELECTRON PAIR. McCoyd, Gerard C. (Saint John's Univ., Jamaica, N. Y. Dept. of Physics). 1965. 180p. (NASA-CR-97466). CFSTI.

Thesis.

The reduced cross section for four-photon annihilation of an electron positron pair is calculated for arbitrary energy. It is integrated for the special case in the nonrelativistic limit in which two of the photons are soft and one hard photon is emitted in a small cone centered on the direction of the incident positron. This result is used to estimate the total cross section for in-flight annihilation in the nonrelativistic limit, and the lifetime of positronium for four photon decay from the 1^1S_0 state. The concept of the reduced cross section affords a considerable economy in computational labor. (STAR) (auth)

30479 (NYO-2262-TA-217) FIELD THEORETIC MODEL OF HIGH ENERGY SCATTERING. III. INELASTIC ELECTRON-PROTON SCATTERING. Fried, H. M. (Brown Univ., Providence, R. I. Dept. of Physics); Gaisser, T. K. (Cambridge Univ. (England)). [1969]. 18p. Dep. CFSTI.

The predictions which follow from a simplified version of the soft, virtual, neutral vector meson field theoretic model are described. It is assumed that neutral vector mesons are copiously produced in inelastic e + p channels and that they can be described by a simple generalization of the soft photon methods conserving energy and momentum exactly in all processes, while approximating the nucleon emission operators by those applicable to the case of soft mesons. The emission probabilities are not computed directly, but are inferred by means of unitarity from the off-shell Compton amplitudes. (J.F.P.)

30480 THEORY OF DEEP-INELASTIC LEPTON-NUCLEON SCATTERING AND LEPTON PAIR ANNIHILATION PROCESSES. II. DEEP-INELASTIC ELECTRON SCATTERING. Drell, Sidney D.; Levy, Donald J.; Yan, Tung-mow (Stanford Univ., Calif.). Phys. Rev., D; 1: 1035-68(15 Feb 1970).

This is the second in a series of four papers devoted to a theoretical study based on canonical quantum field theory of the deep-inelastic lepton processes. The detailed calculations leading to the limiting behavior — or the "parton model" — for deep-inelastic electron scattering are presented. It follows from this work that the structure functions depend only on the ratio of energy to momentum transfer from this work that the structure functions depend only on the ratio of energy to momentum transfer $2M\nu/q^2$ as conjectured by Bjorken on general grounds. To accomplish this derivation, it is necessary to introduce a transverse momentum cutoff so that there exists an asymptotic region in which q^2 and $M\nu$ can be made larger than the transverse momenta of all the virtual constituents or "partons" of the proton that are involved. The ladder approximation is also for the leading contribution, order by order in the strong interaction and to all orders in the coupling, to the asymptotic behavior of these structure functions with increasing ratio of energy to momentum transfer. Finally, the experimental implications are discussed. (auth)

30481 THEORY OF HIGH-ENERGY DIFFRACTION SCATTERING. I. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev., D; 1: 1069-82(15 Feb 1970).

Recent theoretical results on high-energy scattering are extended. It is found that the form of the matrix elements in the high-energy limit can be readily understood in terms of energy denominations in pre-Feynman perturbation theory. On this basis, explicit rules are given to obtain the high-energy behavior of the sums of large classes of Feynman diagrams, for both the scattering of two extremely relativitistic particles and that of one such particle by an external static potential. Application of these rules yields immediately all the previous results on high-energy elastic scattering, and also leads to a deeper understanding of exponentiation. These considerations suggest a simple and natural physical picture for high-energy elastic scattering and, by trivial extensions, also for diffraction and some inelastic scattering processes. It is emphasized that this physical picture has the virtue of correctly yielding all the high-energy results of quantum electrodynamics. (auth)

30482 INVESTIGATION OF ASYMPTOTIC BEHAVIOR IN FIELD THEORY: THE ELASTIC FORM FACTOR. Appelquist, Thomas; Primack, Joel R. (Stanford Univ., Calif.). Phys. Rev., D; 1: 1144-65(15 Feb 1970).

The question whether local relativistic quantum field theory can account for the observed asymptotic behavior of the electromag-

netic form factor of the proton is examined. Particular attention is devoted to the theory of pions and nucleons interacting via isospin-symmetric pseudoscalar coupling, with minimal coupling to the electromagnetic field. New techniques are developed for calculating and summing all asymptotical dominant contributions to vertex functions and to propagators from all orders of perturbation theory. The results indicate that summing Feynman graphs in local quantum field theory is unlikely to provide an explanation of the observed rapid decrease of the form factor at large momentum transfers. (auth)

30483 ELECTRON SELF-ENERGY AND THE COMPTON AMPLITUDES. Fishbane, Paul M. (Univ. of Wisconsin, Madison. Univ. of Illinois, Urbana). Contract AT(11-1)-881. Phys. Rev., D; 1: 1166-71(15 Feb 1970).

A no-subtraction dispersion relation for the electron self-energy is written in the momentum of the electron. The integrand of the dispersion relation is specified to order e^2 by truncating a sum over a complete set of states with one-electron one-photon state. The result, which is a consequence of a mixture of perturbation theory and dispersion theory, is an expression for the electron self-energy as a sum over the E_1 and M_1 phase shifts of the multipole expansion of the Compton scattering amplitude. (auth)

30484 RADIATION FROM A CLASSICAL SPINNING ELECTRON. Kolsrud, Marius (Univ. of Oslo). J. Math. Phys. (N. Y.); 11: 1690(May 1970).

The electromagnetic field given by Cohn, according to which the radiation from a classical spinning point charge is independent of the particle's spin, is shown not to satisfy Maxwell's equations. References are given to earlier expressions, which also correspond with quantum theory. (auth)

30485 ANOMALOUS MAGNETIC MOMENT OF THE MUON AND RELATED TOPICS. Bailey, J.; Picasso, E. (CERN, Geneva). Progr. Nucl. Phys.; 12: 43-75(1970).

The discussion of the anomalous magnetic moment of the muon covers the g-2 experiment performed using the CERN muon storage ring, the muon and special relativity, and more precise g-2 measurements. (J.F.P.)

30486 QUANTUM ELECTRODYNAMICS TEST BY e^+e^- SCATTERING AT 2 x 510 MeV. Augustin, J. E.; Buon, J.; Delcourt, B.; (and others) (Ecole Normale Superieure, Orsay, France). Phys. Lett., 31B: 673-6(11 May 1970).

The absolute cross section σ of Bhabha scattering $e^+e^- \rightarrow e^+e^-$ was measured at a total center of mass energy of 1020 MeV to test quantum electrodynamics. The result is compared to the theoretical cross section modified by adding a positive or a negative metric pole to the photon propagator: $1/q^2 \rightarrow 1/q^2 \pm 1/(q^2 - \Lambda^2)$. A lower limit of Λ is obtained: $\Lambda > 3.8$ GeV (positive metric) or $\Lambda > 2.0$ GeV (negative metric). (auth)

30487 INERT HADRON REACTION FOR THE DETERMINATION OF THE POMERANCHUK TRAJECTORY SLOPE. Barger, V.; Cline, D. (Univ. of Wisconsin, Madison). Phys. Rev. Lett.; 24: 1313-17(8 Jun 1970).

A reaction with no expected secondary Regge poles ($\gamma p \rightarrow \varphi p$) is suggested as a means for direct experimental study of the Pomeranchuk exchange amplitude. From existing data on this reaction, a Pomeranchuk trajectory slope of $\alpha'_P(0) \simeq \frac{1}{2}$ is found. (auth)

30488 EVIDENCE FOR AN ISOTENSOR ELECTROMAGNETIC CURRENT. Sanda, A. I.; Shaw, Graham (Columbia Univ., New York). Phys. Rev. Lett.; 24: 1310-13(8 Jun 1970).

An unambiguous and model-independent test for the presence of isotensor terms in photopion production is suggested. On analyzing the available data, striking evidence for the presence of such a term is found. (auth)

Weak

30489 (CERN-70-14) K_{l3} FORM FACTORS: REVIEW OF THE THEORY; REVIEW OF EXPERIMENTAL RESULTS. Gaillard, M. K.; Chounet, L. M. (European Organization for Nuclear Research, Geneva (Switzerland)). 5 May 1970. 92p. Dep. CFSTI (U. S. Sales Only).

The review of $K \rightarrow \pi + l + \nu$ form factors covers current algebra applied to $K \rightarrow \pi + l + \nu$ decays, experimental results on $K \rightarrow \pi + l + \nu$ form factors, and a comparison of data with theory. An attempt is made to separate the principal assumptions which determine the general behavior of the form factors from calculational details and specific approximations which predict precise values for the relevant parameters. (J.F.P.)

30490 BOUNDS ON THE RANGE OF INCREASE OF WEAK INTERACTION CROSS SECTIONS. Pomeranchuk, I. Ya. Yadern. Fiz.; 11: 852-7(Apr 1970). (In Russian).

Bounds on the energy range of increase of the weak interaction cross sections are considered. Dispersion relations, unitarity, and the general angular dependence of the cross sections are used to obtain the bounds. Considering the forward scattering amplitude one concludes that the weak interaction cross section may increase up to the magnitude of strong interaction cross sections ($\sim 1/m_N^2$) at the energies $\sqrt{s} \geq 1/Gm_N \sim 10^{14}$ eV. Considering the derivative of the amplitude on the momentum transfer, a stronger bound arises, $\sqrt{s} \geq 1/(10 m_N^2 G^{\frac{1}{2}}) \sim 3 \cdot 10^{15}$ eV. (auth)

30491 K MESON LEPTONIC DECAY. Jones, P. B. (Nuclear Physics Lab., Oxford). Progr. Nucl. Phys.; 12: 1-42 (1970).

The charged kaon three-body leptonic decay modes $K^+ \rightarrow e^+ + \mu^0 + \nu$, $\mu^+ + \pi^0 + \nu$ which are mediated by the weak, strangeness nonconserving vector hadronic current, are considered. The neutral modes $K_2^0 \rightarrow e + \pi + \nu$, $\mu + \pi + \nu$ are also discussed. (J.F.P.)

Strong (General)

Refer also to abstract 30506.

30492 (INR-1163) STATISTICAL MODEL AND CROSS SECTIONS FOR HIGH-ENERGY REACTIONS. Bartke, Jerzy (Institute of Nuclear Research, Warsaw (Poland)). 1970. 101p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The application of the statistical model to the calculation of cross sections for high-energy reactions is discussed. Comparison with experimental data includes various many-body and two-body reactions, and, in particular, pion-proton interactions which have as well been studied by the bubble chamber group in Cracow. The discussed model is, in fact, a "restricted" statistical model, assuming only the independence of the reaction matrix of isospins, spins and masses of the produced particles. The relative cross sections for different channels within a given multiplicity, as obtained from the model, are in agreement with experiment. The isospin independence of the reaction matrix may already be considered well established and this allows one to calculate the real multiplicity spectrum of the produced particles. The model should find wider application in the analysis of the cross section results, leading to better understanding of the observed dependences and to some systematics in the rapidly growing amount of experimental data. (auth)

30493 THE RATIO OF REAL PART OF THE SCATTERING AMPLITUDE TO THE IMAGINARY PART IN THE DIFFRACTION PEAK REGION. Arushanov, G. G. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 5, 26-9(1969). (In Russian).

The problem of the ratio of the real part to the imaginary part of the scattering amplitude in the diffraction cone was investigated within the limits of a previously developed simple model of elastic interactions of hadrons at high energies. (R.V.J.)

30494 EXOTIC STATES IN A THREE-TRIPLET QUARK MODEL. Krolikowski, W. (Inst. of Nuclear Research, Warsaw. Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys.; 18: No. 1, 35-7(1970).

The existence of some exotic states in the three-triplet quark model with a binding mechanism provided by a complex charge ascribed to quarks is qualitatively discussed. The simplest quark bound states are listed. It is found that the model predicts both exotic mesons and exotic baryons. Also in the effective-mass region of a quark, there should be some quark bound states very similar to single quarks. (J.F.P.)

30495 EXISTENCE OF FIXED POLES AND THEIR ROLE IN CONSPIRACY. Finkler, Paul (Univ. of Nebraska, Lincoln). Phys. Rev., D; 1: 1172-81(15 Feb 1970).

It is shown that unitarity allows fixed poles at certain nonsense points of either right or wrong signature. The conditions for the existence of these poles are found. These conditions are then used to locate the poles allowed in hadronic reactions. Possible mechanisms for the poles are considered. It is then argued that fixed poles provide the most natural explanation of the conspiracy phenomenon. (auth)

30496 STRUCTURE OF HADRONS IMPLIED BY DUALITY. Susskind, Leonard (Yeshiva Univ., New York). Phys. Rev., D; 1: 1182-6(15 Feb 1970).

The harmonic-oscillator model of hadrons is generalized to include higher harmonics so that the degrees of freedom of the in-

ternal state of a hadron are equivalent to those of a violin string or organ pipe. Scattering amplitudes for the scattering of particles by the oscillator are constructed and shown to be equivalent to the dual-symmetric Veneziano model. The method provides a direct construction of the amplitude in a manifestly factorized form. (auth)

30497 DUAL-SYMMETRIC LOOP DIAGRAMS FROM THE HARMONIC-OSCILLATOR MODEL. Gallardo, Juan C.; Susskind, Leonard (Yeshiva Univ., New York). Phys. Rev., D; 1: 1186-8(15 Feb 1970).

Using the generalized harmonic-oscillator model of hadrons, the amplitude for dual-symmetric Feynman-like diagrams with a single loop is constructed. The result is essentially identical to the expression derived by Veneziano and Virasoro. (auth)

30498 STRUCTURE OF HADRONS. II. NONPLANAR DIAGRAMS. Gallardo, Juan C.; Galli, Eduardo J.; Susskind, Leonard (Yeshiva Univ., New York). Phys. Rev., D; 1: 1189-93 (15 Feb 1970).

Using the harmonic-oscillator model for hadrons, in which any hadron is described by two quarks embedded in a one-dimensional harmonic continuum, and allowing quanta to couple to either quark, the full crossing-symmetric Veneziano type of amplitude was constructed in the tree-graph approximation. This generalization also gives us a set of rules to compute the nonplanar single-loop diagrams. (auth)

30499 DUAL-SYMMETRIC HARMONIC-OSCILLATOR MODEL OF HADRONS FOR ARBITRARY GROUND-STATE MASS. Frye, Graham (Yeshiva Univ., New York). Phys. Rev., D; 1: 1194-7(15 Feb 1970).

The harmonic-oscillator model of hadrons is extended so that it is dual- and crossing-symmetric for any value of the ground-state mass. The new feature of the model system is an extra nonspatial harmonic mode associated with each quark. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 30434, 30448–30450, 30456, 30521, 30533, and 30590.

30500 (CONF-690521) PROCEEDINGS OF THE CONFERENCE ON $\pi\pi$ and Kπ INTERACTIONS, MAY 14, 15, AND 16, 1969, ARGONNE NATIONAL LABORATORY. Loeffler, Frank; Malamud, Ernest (eds.) (Argonne National Lab., Ill. Purdue Univ., Lafayette, Ind.). 776p. Dep. CFSTI.

Forty papers are included; separate abstracts are prepared for thirty. One paper not abstracted for NSA consisted of comments on one of the contributed papers. Nine papers were previously abstracted for NSA; see CONF-690521 in a cumulative report number index. (L.B.S.)

For abstracts of individual papers see: 30427, 30434, 30439, 30448–30458, 30476, 30501–30510, 30520–30522, 30533, and 30590.

30501 (CONF-690521-, pp 306-15) STUDY OF $\pi\pi$ PHASE SHIFTS BELOW THE ρ REGION. Scharenguivel, J. H. (Purdue Univ., Lafayette, Ind.).

The δ_0^0 phase shift determination was extended for 0.35 GeV < $\sqrt{s}$ < 0.6 GeV region. The effects of possible ω exchange on an earlier determination of δ_0^0 in the ρ^- region were studied. No significant ω exchange was found. From the extrapolated $\pi^+\pi^-$ angular distribution δ_1^1 and δ_0^0 were determined. (auth)

30502 (CONF-690521-, pp 487-507) Kπ ELASTIC SCATTERING STUDIED BY THE CHEW-LOW EXTRAPOLATION METHOD. Henri, Victor P. (European Organization for Nuclear Research, Geneva (Switzerland)).

The determination of the total Kπ elastic and charge exchange cross sections, using the Chew–Low extrapolation method, is described. The method was adapted to the process $K^+p \to Kp\pi\pi$. The extrapolated cross sections are discussed and are tabulated for $K^+\pi \to K^+\pi^-$, $K^+\pi^- \to K^0\pi^0$, and $K^+\pi^0 \to K^0\pi^+$ interactions. The off-shell $K^+\pi^-$ angular distribution is discussed and its momentum transfer dependence is indicated. An attempt to study the extrapolated Kπ angular distribution confirms the qualitative features observed for the off-shell moments. (L.B.S.)

30503 (CONF-690521-, pp 508-19) $K^+\pi^-$ SCATTERING CROSS SECTION AND PHASE SHIFTS STUDIED IN THE REACTION $K^+p \to K^+\pi^-\Delta^{++}$. Antich, P.; Callahan, A.; Carson, R.; (and others) (Johns Hopkins Univ., Baltimore, Md.).

A study of the $K^+\pi^-$ scattering cross section and phase shifts from the reaction $K^+p \to K^+\pi^-\Delta^{++}$ shows that the Chew-Low extrapolation using the one-pion-exchange model is quite successful in predicting the known behavior of the p-wave, T = ½ $K^+\pi^-$ interaction, though the degree of success depends on the physical region used. The total cross section obtained showed little evidence of resonant behavior in the 1100 to 1200 MeV region. The T = ½, s-wave phase shift is shown to rise slowly from zero at threshold, passing through 90° near 1150 MeV; this behavior could not be interpreted as evidence for a resonance. (L.B.S.)

30504 (CONF-690521-, pp 562-618) $\pi\pi$, Kπ, K$\bar{\text{K}}$ PHASE SHIFTS AND THEIR OFF SHELL DEPENDENCE FROM UNITARIZED VENEZIANO FORMULA. Lovelace, C. (European Organization for Nuclear Research Geneva (Switzerland)).

Meson–meson Veneziano formulas are reviewed. By interpreting them as the K matrix, phase shifts are deduced, generally in good agreement with experiment. In principle there are no free parameters. The theory of $\pi\pi$ elastic scattering has now accounted for virtually all experimental evidence on this process. Its off-shell dependence in peripheral experiments is also correctly predicted. (auth)

30505 (CONF-690521-, pp 619-47) SURVEY OF CURRENT ALGEBRA ANALYSES OF $\pi\pi$ AND Kπ INTERACTIONS. Arnowitt, R. (Northeastern Univ., Boston, Mass.).

A brief survey is given of some attempts during the past few years to describe $\pi\pi$ and Kπ interactions by means of current algebra techniques. The following topics are discussed: soft pion analysis of $\pi\pi$ threshold parameters; hard pion methods; decay distributions of $\eta \to 3\pi$ and $K_- \to 3\pi$; K_{l3} decay; Kπ scattering; and the Veneziano model. (66 references) (L.B.S.)

30506 (CONF-690521–, pp 648-64) GHOSTS AND GOETTER-DAEMMERUNGEN. Yellin, Joel (California Univ., Berkeley. Lawrence Radiation Lab.).

Some general remarks are made concerning theories of strong interactions having two important dynamic properties: linearity for squared masses, and duality. The duality principle is illustrated for $\pi\pi$ scattering. (L.B.S.)

30507 (CONF-690521-, pp 715-25) RIGOROUS INEQUALITIES ON $\pi\pi$ PARTIAL WAVE AMPLITUDES. Auberson, G.; Mahoux, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Brander, O.; Martin, A. (European Organization for Nuclear Research Geneva (Switzerland)).

The problem of imposing crossing symmetry on partial wave amplitudes of pion–pion scattering is considered. A method is presented that allows rigorous inequalities that hold for truncated partial wave expansions to be derived in a relative systematic way and gives back the exact crossing symmetry condition in the limit of infinite angular momentum. (L.B.S.)

30508 (CONF-690521–, pp 740-9) NON-EVASIVE CHEW–LOW EXTRAPOLATION FOR THE STUDY OF $\pi\pi$ ELASTIC SCATTERING. Froggatt, C. D. (University Coll., London (England). Dept. of Physics); Morgan, D. (Rutherford High Energy Lab., Chilton (England)).

A recent analysis of (+ –) dipion production indicates that the extrapolated production cross section does not vanish at t = 0 as it would for OPE. A model for this phenomenon is presented in which the spin and dipion mass dependencies of the background are simply parameterized. This suggests a new prescription for performing Chew–Low extrapolation. (auth)

30509 (CONF-690521–, pp 750-8) COMMENTS ON EXTENSIONS OF THE VENEZIANO AMPLITUDE TO $\bar{p}n \to 3\pi$. Berger, Edmond L. (California Univ., Berkeley., Lawrence Radiation Lab.).

Lovelace's fit to data on $\bar{p}n$ annihilation at rest into three pions using the Veneziano parameterization is examined critically. An alternative fit is presented, and some remarks are made on the physical significance of the fits. (L.B.S.)

30510 (CONF-690521–, pp 759-64) COMMENT ON THE ISOSPIN TWO $\pi\pi$ AMPLITUDE. Olsson, M. G. (Wisconsin Univ., Madison).

A simple duality estimate of the d-wave phase shift in the $\pi\pi$ system is shown to be roughly consistent with standard OPE interpretation. (L.B.S.)

30511 (IFVE-STF-69-26) 0(4) SYMMETRIES AND ρ MESONS PRODUCTION PROCESSES. Zamiralov, V. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1969. 17p. (In Russian). Dep. CFSTI (U. S. Sales Only).

An expansion of the helicity amplitudes of the single and coupled ρ^0 and 33-isobar production amplitudes is considered assuming the little group at t = 0 being 0(4). The analysis of the Regge trajectories contributions is performed taking account of their 0(4)-classification. The expansions of the spin-nonflip amplitudes along the 0(4) are presented for processes $\pi\pi \to \rho\rho$ and $NN \to \Delta\Delta$, which allows writing the relations of factorization.

The qualitative comparison of the results with the presence of peaks in the ρ^0-production experiments is made. (auth)

30512 $\bar{p}n$ ELASTIC SCATTERING FROM $-t = 0.15$ TO 1.0 $(GeV/c)^2$ AT 3.5 GeV/c. Reynolds, B. G.; Weaver, K. E.; Bishop, J. M.; Huwe, D. O.; Malko, J. A. (Ohio Univ., Athens). Phys. Rev. Lett.; 24: 1251-3(1 Jun 1970).

The $\bar{p}n$ differential elastic cross section was measured in the four-momentum–transfer region of $-t = 0.15$ to 1.0 $(GeV/c)^2$ using neutron scatters obtained in a $\bar{p}d$ bubble chamber experiment at 3.5 GeV/c. The $\bar{p}n$ elastic cross section is similar to the $\bar{p}p$ cross section at this energy to the extent that both cross sections exhibit a diffraction peak and a dip at $-t \simeq 0.45$ followed by a secondary peak. A comparison of $\bar{p}n$ and $\bar{p}p$ elastic scattering indicates a crossing of the two cross sections near the region of the dip. The results of this experiment suggest the presence of an I = 1, t-channel exchange in $\bar{N}N$ scattering. (auth)

30513 NONRELATIVISTIC BOUND STATES IN THE NUCLEON–ANTINUCLEON SYSTEM. Dal'karov, O. D.; Mandel'tsveig, V. B.; Shapiro, I. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 889-95(Apr 1970). (In Russian).

It is shown that in the mass region 1580–1880 MeV there is a number of close meson resonances with width of the order of some dozens of MeV's being the quasinuclear bound states of the nucleon-antinucleon system. The quantum numbers of these resonances are $J^{PG} = 0^{--}$, 0^{-+}, 1^{--}, 1^{-+}. (auth)

30514 A MODEL FOR THE AXIAL-VECTOR-CURRENT THREE-PION AMPLITUDE CONSISTENT WITH CURRENT ALGEBRA, THE ADLER CONSISTENCY CONDITION, AND THE GENERALIZED VENEZIANO MODEL. Cooper, Fred (Cornell Univ., Ithaca, N. Y. Univ. of California, Berkeley). Phys. Rev., D; 1: 1140-4(15 Feb 1970).

Using spurion techniques on the five-point function for $\pi\sigma \to \pi\pi\pi$, an expression is obtained for $A^\mu\pi \to \pi\pi$ for a conserved axial-vector current which has poles along the $\pi - A_1$ trajectory in the current momentum squared whose residues are Veneziano-type strong-interaction amplitudes satisfying the Adler consistency condition. Using the soft-pion theorem, a simple expression is obtained for the pion form factor, $F(q^2) = \pi^{-1}[\Gamma(\frac{1}{2})\Gamma(-q^2 + \frac{1}{2})\Gamma(-\gamma_2 + \frac{1}{2})/\Gamma(-q^2 - \gamma_2 + \frac{1}{2})]$, where $-\gamma_2$ is a constant and is related to the s-wave coupling constant in the $A_1\rho\pi$ vertex. (auth)

30515 REACTIONS $A\pi \to A\pi$ AND $A\pi \to \pi\pi$ IN THE VENEZIANO MODEL. Carruthers, P.; Cooper, F. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 1: 1223-39(15 Feb 1970).

In order to find the effect of spin and isospin on the construction of a Veneziano amplitude, the reaction $A\pi \to A\pi$ was analyzed. This reaction involves the (degenerate) ρ-f trajectory in both channels. In order to construct an amplitude possessing crossing symmetry, proper asymptotic behavior, and pole structure, as well as signature and factorization for the leading trajectory, it is necessary to include three independent beta functions in an expansion of the form (polynomials) × (beta functions). It is found that, to avoid parity doubling on the leading trajectory and to keep the $A\rho\pi$ coupling from vanishing, it is necessary to have a conspiracy among three of the invariant amplitudes for all values of s. The conspiracy, signature, and factorization constraints provide a large number of constraints, but do not fully determine the amplitude. The $A\rho\pi$ couplings are undetermined by the foregoing constraints. The amplitude is sufficiently flexible to satisfy the Adler condition and to agree with current-algebra determination of the threshold amplitude. (These conditions only lead to two constraints.) The simpler reaction $A\pi \to \pi\pi$ is analyzed in detail. For this reaction, it is possible to find a minimal amplitude satisfying asymptotic behavior and soft-pion constraints, and only one over-all undetermined constant. (auth)

30516 REACTION $\omega\pi \to \omega\pi$ IN THE VENEZIANO MODEL. Carruthers, P.; Lasley, Eric (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., D; 1: 1204-12(15 Feb 1970).

A set of invariant amplitudes for the reaction $\omega\pi \to \omega\pi$ is constructed within the framework of the Veneziano model by expansions of the form Σ (polynomials) × (beta function). The dominant asymptotic behavior corresponds to the f trajectory in the t channel and the ρ and B trajectories in the s and u channels. Separate treatments are given for the ρ and B contributions. In every case the leading trajectory poles have correct spin-parity as a consequence of enforcing proper asymptotic behavior on the invariant amplitudes. These relations are nontrivial and differ for the ρ and B contributions. The detailed construction of the amplitudes for $\omega\pi$ scattering differs from most previous applications because of the absence of an exotic channel. $\omega\pi$ scattering is notable in the number of terms required to represent the amplitude; a 72-parameter amplitude built using B_{11}, B_{12}, and B_{21} cannot satisfy simple physical requirements for the ρ trajectory. One must add further terms lacking the ρ pole (such as B_{22}) in order to avoid decoupling the ρ trajectory. The B contribution is easily treated in direct analogy to the ρ trajectory in $A\pi$ scattering. The implication of the hypothesis of partially conserved axial-vector current (PCAC) that the invariant amplitude T_1 (coefficient of $e' \cdot e$) should vanish at the Adler point is somewhat delicate because of the near degeneracy of the ω and ρ mesons. The signature and amplitude conspiracy relations ensure the suppression of the apparent pole. (auth)

30517 LOW ENERGY S-WAVE $\pi\pi$-PHASE SHIFTS FROM ANALYSIS OF INELASTIC REACTIONS. Makarov, M. N.; Gasilova, N. S.; Nelubin, V. V.; Sarantsev, V. V.; Tkach, L. N. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 31B: 666-8(11 May 1970).

Low energy S-wave $\pi\pi$-phase shifts δ_0^0 and δ_0^2 were determined by the analysis of the $\pi\pi$-scattering total cross sections and the angular distribution of pions. (auth)

30518 INTEGRAL INEQUALITIES FOR THE s- AND p-WAVE $\pi\pi$ PARTIAL-WAVE AMPLITUDES DUE TO CROSSING SYMMETRY AND POSITIVITY. Balachandran, A. P.; Blackmon, M. L. (Syracuse Univ., N. Y.). Phys. Lett., 31B: 655-7(11 May 1970).

An infinite number of inequalities for the s- and p-wave $\pi\pi$ scattering amplitudes are derived. They follow from crossing symmetry and from the positivity of the even $l \geq 2$ partial waves of the reactions $\pi^0\pi^0 \to \pi^0\pi^0$ and $\pi^0\pi^0 \to \pi^+\pi^-$ in the region $0 \geq s \geq 4m_\pi^2$. (auth)

30519 DYNAMICS OF HADRON AND URBARYON. Ohnuki, Yoshio (Nagoya Univ., Japan). Soryushiron Kenkyu; 40: No. 4, D35-8(Dec 1969). (In Japanese).

A nonrelativistic urbaryon model gave interesting results in conjunction with the SU(6) theory. The recent success of the chiral symmetry, however, suggests that the simple nonrelativistic image is inadequate. Considering the urbaryon as a particle, though it may not be, a discussion is developed. This discussion shows that the particle-like character of the urbaryon cannot be denied in low energy phenomena, while the reaction at higher energy presents problems. (NSA of Japan)

Strong (Baryon No. = 1)

Refer also to abstracts 30456, 30533, and 30547.

30520 (CONF-690521–, pp 27-54) DETERMINATION OF δ_0^0 FROM THE FACTORIZATION MODEL AND BACKWARD–FORWARD ASYMMETRY. Carmony, D. D. (Purdue Univ., Lafayette, Ind.).

A recent analysis of the reaction $\pi^-p \to n\pi^+\pi^-$ using a compilation of current two-prong data at beam momenta between 1.89 and 3.2 GeV/c is discussed. The analysis is restricted to the events with a four-momentum transfer to the dipion system of less than 10 pion masses squared and to the $\pi\pi$ mass region 0.6 to 0.9 GeV/c^2. The forward–backward asymmetry is extrapolated to the pion pole, and the I = 0 s-wave $\pi\pi$ phase shift is obtained using the factorization model. (L.B.S.)

30521 (CONF-690521–, pp 75-92) $\pi\pi$ PHASE SHIFTS IN THE 1.0- TO 1.4-GeV REGION. Oh, B. Y.; Walker, W. D.; Carroll, J.; Firebaugh, M.; Garfinkel, A.; Morse, R. (Wisconsin Univ., Madison); Prentice, J.; Steenberg, N. R.; West, E. (Toronto Univ. (Ontario)).

An enhancement previously observed in the $\pi^-\pi^+$ mass spectrum in the 1.1 to 1.2 GeV region is analyzed from a study of the reactions $\pi^-p \to \pi^-\pi^+n$, $\pi^-p \to \pi^-\pi^0p$, and $\pi^+d \to \pi^-\pi^+pp$ at 7 GeV/c. It is shown that the anomaly of the $\pi^-\pi^+$ state in this region could be due to a slowly varying p-wave scattering amplitude, which interferes strongly with a rapidly growing I = 0, d-wave amplitude. (L.B.S.)

30522 (CONF-690521–, pp 533-61) WHAT CAN WE LEARN FROM VIRTUAL PIONS? Kane, G. L. (Michigan Univ., Ann Arbor).

The current status of the long-standing effort to obtain information about scattering processes involving virtual particles is discussed. The first part of the study is devoted to the question of when is pion exchange sufficiently important in a process so that extrapolation can be performed with confidence. In the second part, a purely pion exchange process is assumed, and the question is considered of whether the corrections due to the fact that the pion is a virtual one, with imaginary mass and presumably with non-integral spin, can be understood well enough to obtain the information needed from extrapolation. (L.B.S.)

30523 (ITF-70-23) VECTOR MESON PRODUCTION AND THE FACTORIZABILITY QUARK MODEL. Kobushkin, A. P. (Akad-

emiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The processes $O^- + P \rightarrow 1^- + 1/2^+$ are investigated on the basis of the factorizability quark model at high energies. It is shown that the quark spin-flip amplitudes have to be taken into account in the reactions. The obtained relations are compared with experiment. (auth)

30524 NEW APPROACH TO THE HIGH ENERGY INTERACTION. Muraki, Yasushi (Nagoya Univ., Japan). Uchusen Kenkyu; 14: 217-26(Oct 1969). (In Japanese).

A hypothesis analogous to the excited baryon model is proposed to explain the constant mass of fire-balls and the constant inelasticity of high energy interaction. It was assumed that a nucleon has the cloud of virtual π-meson around its core, and it is the ground state and the S-wave, the nucleon system has Gaussian density distribution, the total cross section for $\pi + p$ is constant even in the high-energy region, and the virtual π-meson is transformed into $(N\bar{N})$ due to the collision with a nucleon as proposed by Williams and Weiszacker. The energy spectrum of the virtual π-meson was calculated as the Fourier transform of density distribution. The equation representing the dependence of energy transfer ΔE on incident energy was derived. At the high-energy limit, ΔE i.e., the mass of fire ball is constant. The fluctuation of the number of secondary particles as well as its mode of increase with incident energy can be correctly calculated with this model. The angular distribution of fire balls and nucleon pair production are also discussed. The present model was compared with the H quantum model. A calculation was performed for the interaction of high energy leptons and nucleons. Implication of the $\mu + N$ or the $\nu + N$ reaction in the high energy region is discussed. (auth)

30525 ACCOUNT OF INTERMEDIATE ENERGY REGION IN DISPERSION SUM RULES. Aznauryan, I. G.; Solov'ev, L. D. (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 11: 870-9(Apr 1970). (In Russian).

A method is developed to account for the intermediate energy region in the dispersion sum rules. The method makes it possible to find the parameters for the high energy processes with use of the low-energy phase-shift analysis. The method is applied to obtain the Regge-pole residues for the amplitudes $B^{(\pm)}(\nu,t)$ of the pion-nucleon scattering. This enables one to predict, in particular, the magnitude of rotation of the nucleon spin in the high energy $\pi^{\pm}p$ scattering in framework of the Regge-pole model. (auth)

30526 K* (892) PRODUCTION IN THE RESCATTERING MODEL. Saxena, A. B.; Agarwal, B. K.; Singh, C. P. (Allahabad Univ., India). J. Phys., A (London); 3: 280-3(May 1970).

The rescattering model was applied to explain the observed angular distributions at various energies for the process $K^-p \rightarrow K^{*-}p$. The theoretical calculations are in reasonable agreement with experiments regarding magnitude, shape and energy dependence. (auth) (UK)

30527 HIGH-ENERGY MULTIPLE SCATTERING BY THE VIRTUAL-MESON CLOUD. Remler, E. A. (Coll. of William and Mary, Williamsburg, Va.). Phys. Rev., D; 1: 1214-16(15 Feb 1970).

The sum of all ladder-type diagrams contributing to the scattering of two scalar nucleons in evaluated in the high-energy approximation. It results in an expression for the eikonal function in closed form which is, however, purely real. Possible sources of this difficulty are discussed. (auth)

30528 DYNAMICAL THRESHOLD EFFECTS IN A WORLD WITH MASS-ZERO PIONS. Sawyer, R. F. (Univ. of California, Santa Barbara). Phys. Rev., D; 1: 1216-22(15 Feb 1970).

On a dynamical basis which incorporates analyticity, multi-soft-pion production, and multiparticle unitarity, it is concluded that in a world in which the pion mass is zero, the Regge parameters α for nucleon (and nucleon-resonance) trajectories should have a threshold behavior that differs with the normal behavior in a world with $m_\pi \neq 0$. A discussion is given of the relationship of these results to (a) possible parity doubling of baryon trajectories and (b) unitarization schemes for models with initially real trajectories. (auth)

30529 REMARK ON THE MARTIN–NEWTON CONDITION FOR SOLUBILITY OF THE ELASTIC UNITARITY INTEGRAL EQUATION. Goldberg, Haim (Tel-Aviv Univ., Israel). Phys. Rev., D; 1: 1242-3(15 Feb 1970).

Martin and Newton have proved some sufficient conditions of solubility and uniqueness for the unitarity integral equation. Application to experimentally known differential cross sections justified by appropriate assumptions shows that these conditions are, in general, not satisfied. Similarly, the angular distribution discussed by Crichton does not meet the solubility condition. (auth)

30530 UNCONVENTIONAL ASYMPTOTICS. Barger, V. (Univ. of Wisconsin, Madison); Phillips, R. J. N. Contract AT(11-1)-881., Phys. Lett., 31B: 643-6(11 May 1970).

The question of whether the high energy πN and KN scattering amplitudes may contain unconventional terms leading to violation of the Pomeranchuk theorem and/or logarithmically increasing cross sections is considered. The total cross section and forward real part data, with dispersion relation constraints, are consistent with appreciable terms of these kinds. (auth)

30531 LACK OF DIP SYSTEMATICS IN STRONG CUT MODELS. Drago, F.; Love, A.; Phillips, R. J. N.; Ringland, G. A. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Lett., 31B: 647-50(11 May 1970).

Recent data on backward $K^-n \rightarrow \Lambda\pi^-$ suggest that this reaction could discriminate between the Argonne and Michigan Regge cut models, on the basis of their differing dip systematics. Closer investigation shows, however, that dip structure in the Michigan model is extremely sensitive to parameters (contrary to what has usually been claimed), so that meaningful tests of this model cannot be made on this basis. This general conclusion does not depend on particular data. (auth)

Strong (Baryon No. ≥ 2)

30532 (BMBW-FBK-70-5) PHENOMENOLOGICAL LOCAL SOFT-CORE NUCLEON–NUCLEON POTENTIAL. Eikemeier, H. (Tuebingen Univ. (West Germany). Institut fuer Theoretische Physik). Feb 1970. 55p. (In German). Dep. CFSTI (U. S. Sales Only). ZAED DM 11.60.

The parameters of a phenomenological local charge-independent soft-core nucleon–nucleon potential with central, spin-orbit, and tensor terms were fitted to the experimental data for the four two-nucleon states. The radial dependences are represented by sums of Gaussian functions. A potential of this kind is particularly suited for calculations in nuclear physics, because it can be handled easily. Especially it simplifies calculations in the harmonic oscillator shell model and in the refined cluster model. (auth)

30533 (CONF-690521–, pp 1-26) EXPERIMENTAL VALIDITY OF ONE-PION EXCHANGE AND PROSPECTS FOR STUDYING $\pi\pi$ AND $K\pi$ SCATTERING. Colton, Eugene; Schlein, Peter (California Univ., Los Angeles).

The extraction of $\pi\pi$ and $K\pi$ cross sections from experimental data on peripheral processes of the type $Xp \rightarrow Y\Delta^{++}$, where X may be either $\pi^{\pm}$, $K^{\pm}$, p, or $\bar{p}$, is examined. Three essential aspects of peripheral processes are discussed: the distribution in the Chew–Low plane; inelasticity at the $X\pi$ vertex; and the angular distribution of X_f in the $(X_f\pi^{\pm})$ rest frame. Results obtained from a reasonably high statistics proton-proton bubble chamber experiment at 6.6 GeV/c are presented. (L.B.S.)

30534 ONE-BOSON-EXCHANGE TYPE NUCLEON–NUCLEON POTENTIAL. Kishi, Yosuke (Ehime Univ., Matsuyama, Japan). Soryushiron Kenkyu; 40: No. 4, D16-18(Dec 1969). (In Japanese).

The one-boson-exchange type potential was previously determined so as to fit for two-nucleon scattering data. It was reanalyzed especially for the potential in the triplet even state, including the data on the deuteron. The potential corresponding to the case was used in which one pion, one scalar boson and one vector boson are exchanged between two nucleons. The main features of the potential are as follows. The value of hard core radius is small ($X_c = 0.22/m_\pi$). The L-S force in the triplet even state is weak. The attractive tensor force in the triplet even state is small. It becomes positive in the inside. Because of the third feature, a large value of $^3D_1$ phase shift and a small value of the mixing parameter ϵ_1 are obtained at high energy. The calculated D state probability P_0 and quadrupole moment Q_d of deuteron are small, and these facts are due to the weak attraction of the tensor force. However, as for Q_d, the contribution of current by meson-exchange should be considered. When this consideration is properly taken into account, the present results do not contradict the experimental values. (auth)

30535 A CONTRIBUTION TO THE PROBLEM OF MECHANISM OF THE $pp \rightarrow \pi^+pn$ REACTION AT THE ENERGY OF 660 MeV. Vovchenko, V. G.; Kostanashvili, N. I.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 810-13(Apr 1970). (In Russian).

Experimental data on the integral energy spectrum and on the angular dependence of the shape of the π^+-meson spectrum in

c.m.s. for the pp → π^+pn reaction at 660 MeV are compared with the calculations based on the resonance model of the pion production. The spectrum is shown to be reasonably described by means of the resonance model with account of the $^3P_{0,1,2}$, $^1D_2$ and $^3F_{2,3}$ initial two-proton states, while the angular dependence of the spectrum shape is in contradiction to the resonance model predictions. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 30552 and 30564.

30536 (JINR–E2-5020) REPRESENTATIONS OF THE LORENTZ GROUP ON THE TWO-DIMENSIONAL COMPLEX SPHERE AND TWO-PARTICLE STATES. Huszar, M.; Smorodinskii, Ya. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 16p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Two-particle spherical functions transforming according to unitary representations of the Lorentz group are constructed. (auth)

30537 SPONTANEOUS BREAKINGS OF CHIRAL SYMMETRIES. Cicogna, G. (Univ., Pisa, Italy); Strocchi, F.; Vergara Caffarelli, R. Phys. Rev., D; 1: 1197-1203(15 Feb 1970).

The spontaneous breakings of chiral SU(3) ⊗ SU(3) and SU(2) ⊗ SU(2) are analyzed in detail. The directions along which the two groups may break spontaneously are determined. The physical implications of these group-theoretical results, as the appearance of Goldstone particles, the particle mixings, and the consequences of the residual invariance are also discussed. (auth)

30538 E2-PARAMETRIZATION OF SL(2,C). Iverson, G. J.; Mack, G. (Univ. of Miami, Coral Gables, Fla.). J. Math. Phys. (N. Y.); 11: 1581-4(May 1970).

The $\overline{E2}$-parametrization of unimodular 2×2 matrices $A \in SL(2,C)$ is considered. $\overline{E2}$ is a covering of the group of Euclidean motions in the plane. The correspondingly factorized matrix elements of the unitary representations of SL(2,C) in an $\overline{E2}$-basis are computed; the result is given. As a fringe benefit an integral transform is obtained which amounts to expansion in terms of Meijer G-functions and which generalizes the familiar Hankel transform. The results are useful, e.g., for computing vertex functions in the theory of massless particles with continuous spin. (auth)

30539 REPRESENTATIONS OF THE LORENTZ GROUP: NEW INTEGRAL RELATIONS BETWEEN LEGENDRE FUNCTIONS. Pajas, P.; Winternitz, P. (Rutherford High Energy Lab., Chilton, Eng.). J. Math. Phys. (N. Y.); 11: 1505-10 (May 1970).

New integral relations between Legendre functions of the first and second kind are derived. These functions figure as the basis functions of the irreducible representations of the homogeneous Lorentz group, so that the derived formulas have direct applications to invariant expansions of relativistic amplitudes. (auth)

30540 UNITARY REPRESENTATIONS OF THE GROUP SL(3,C) IN AN SU(3) BASIS. Mukunda, N. (Tata Inst. of Fundamental Research, Bombay). J. Math. Phys. (N. Y.); 11: 1759-71(May 1970).

Unitary irreducible representations of the group SL(3,C) are obtained in an SU(3) basis. The principal nondegenerate and principal degenerate series of representations are considered, and the matrix elements of the generators are worked out by the use of expansion formulas expressing them as functions of the generators of the group SU(3) × T_8. The forms of the Casimir operators of SL(3,C) and their values in these representations are also given. (auth)

30541 RECURRENCE RELATIONS FOR THE MULTIPLICITIES IN THE CLASSICAL GROUPS. Gruber, B. (Univ. of Helsinki. St. Louis Univ.). J. Math. Phys. (N. Y.); 11: 1783-90(May 1970).

Recurrence relations for the "outer multiplicity" (multiplicity of irreducible representations occurring in the reduction of the direct product of two irreducible representations) as well as the "branching multiplicity" (multiplicity of irreducible representations into which an irreducible representation of a group decomposes, if this group is restricted to a subgroup) are obtained. These recurrence relations are shown to be closely related to each other. Racah has obtained a recurrence relation for the "inner multiplicity" (multiplicity of weights). It turns out that the recurrence relation for the inner multiplicity is a special case of the recurrence relation for the outer multiplicity which, in turn, can be looked upon as a special case of recurrence relation for the branching multiplicity. Moreover, Kostant's recurrence relation for the partition function as well as Racah's recurrence relation for the inner multiplicity have been generalized. This generalization introduces a parameter which can be used to simplify actual calculations. Finally, a formula is given which allows one to calculate the branching multiplicity from known inner multiplicities of the subgroup to which it is restricted. (auth)

30542 EXPANSION OF THE INHOMOGENEOUS PSEUDO-UNITARY SYMPLECTIC LIE ALGEBRAS IUSp($2\nu_1$,$2\nu_2$) TO USp($2\nu_1 + 2$,$2\nu_2$) OR TO USp($2\nu_1$,$2\nu_2 + 2$). Nagel, John G. (Chalmers Univ. of Tech., Goteborg). J. Math. Phys. (N. Y.); 11: 1779-82 (May 1970).

It is shown that the inhomogeneous pseudo-unitary symplectic Lie algebra IUSp($2\nu_1$,$2\nu_2$) can be expanded to USp($2\nu_1 + 2$,$2\nu_2$) or to USp($2\nu_1$,$2\nu_2 + 2$). Also a $(2\nu_1 + 2\nu_2 + 2)$-dimensional linear Lie group G($2\nu_1 + 2\nu_2 + 2$,R) ≅ JUSp($2\nu_1$,$2\nu_2$) is identified which under this expansion is being globally expanded to a $(2\nu_1 + 2\nu_2 + 2)$-dimensional linear group $\epsilon(2\nu_1 + 2, 2\nu_2; R) \cong$ USp($2\nu_1 + 2$, $2\nu_2$) or to $\epsilon(2\nu_1, 2\nu_2 + 2; R) \cong$ USp($2\nu_1$,$2\nu_2 + 2$). (auth)

30543 REDUCTION OF THE MOST DEGENERATE REPRESENTATIONS OF $SO_0(p,q)$ WITH RESPECT TO $SO_0(p-1,q-1) \times T_{p+q-2}$. Castell, L. (International Centre for Theoretical Physics, Trieste, Italy). J. Math. Phys. (N. Y.); 11: 1669-72(May 1970).

The reduction of three principal series of the most degenerate unitary irreducible representations of the identity component of the noncompact rotation groups $SO_0(p,q)$ with respect to the identity component of the inhomogeneous rotation group $SO_0(p-1, q-1) \times T_{p+q-2}$ is carried out, using the results of the reduction with respect to the maximal compact subgroup SO(p) ⊗ SO(q). (auth)

30544 INVESTIGATION OF NONLINEAR REALIZATIONS OF CHIRAL GROUPS BY THE METHOD OF GENERATING FUNCTIONS. Zupnik, B. M.; Ogievetskii, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 1: 19-33(Oct 1969). (In Russian).

An exhaustive analysis was made of nonlinear realizations of chiral groups $U_n \times U_n$ and $SU_n \times SU_n$, which are linearized on the subgroups U_n and SU_n respectively. The analysis is based on the generating functions method using Sylvester–Lagrange polynomials. The nonlinear realizations of the $SU_n \times SU_n$ chiral group are proved to be determined uniquely up to a canonical redetermination of field variables, and the generating functions method makes it possible to find the change of field variables necessary. Unlike semisimple groups the group $U_n \times U_n$ is shown to possess unequivalent nonlinear realizations. (auth)

30545 REPRESENTATIONS OF THE POINCARE GROUP IN THE E(2) BASIS. Novozhilov, Yu. V.; Prokhvatilov, E. V. (Leningrad State Univ.). Teor. Mat. Fiz.; 1: 101-19(Oct 1969). (In Russian).

The unitary irreducible representations of the quantum mechanical Poincaré group based on the subgroup E(2) are constructed in the case of positive values of the mass squared $M^2 > 0$ and energy $P_0 > 0$. The formulas for the generators and the transformation functions from the canonical to the E(2) basis are obtained. The reduction of the direct product of irreducible representations is also considered. (auth)

Applications (Electromagnetic and Weak)

30546 POSSIBLE TEST OF THE LEPTON CHARGE CONSERVATION BY MEANS OF IMPULSE GENERATOR OF ANTINEUTRINOS. Borovoi, A. A.; Loboda, S. V.; Mikaelyan, L. A. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 11: 790-4 (Apr 1970). (In Russian).

A possible search for the reaction $^{19}F + \bar{\nu}_e \rightarrow {}^{19}Ne + e^-$, forbidden by the lepton charge conservation, in the impulse antineutrino beams is considered. An express radiochemical method to extract ^{19}Ne from a large volume of the target matter is elaborated at a model set-up. A sensitive detector to find ^{19}Ne by its decay products is constructed. On basis of preliminary experiments one may conclude that the reaction will be detected if its cross section be at least 1% of the cross section of the reaction $\nu_e + {}^{19}F \rightarrow {}^{19}Ne + e^-$, allowed by the lepton charge conservation. (auth)

30547 THEORY OF RELATIVISTIC SUPERMULTIPLETS. I. BARYON SPECTROSCOPY. Kursunoglu, Behram (Univ. of Miami, Coral Gables, Fla.). Phys. Rev., D; 1: 1115-32(15 Feb 1970).

The energy levels of the hadron are described by a Lorentz-invariant wave equation in the form of supermultiplets. The mass levels belong to the finite-dimensional reducible representations of the group G = U(3,1) ⊗ SO(3,2) whose generators form the algebraic basis of the wave equation. All the states are occupied and therefore, for baryons, there are no supplementary conditions imposed on the wave function. The level spacings are mostly regulated by a constant ρ of the theory, which for $\rho > 1$ leads to a hadron type of spectrum for various multiplets, in which case the deviation from the G symmetry is of the order $1/\rho$. The dimension numbers N and N_0 of the U(3,1) and SO(3,2), respectively, assume the roles of principal quantum numbers to differentiate between the various spin supermultiplets. The N_0 distinguishes also between Fermi–Dirac ($N_0 = 4$) and Bose–Einstein systems ($N_0 = 5, 10$). The spin multiplicities for $N_0 = 4$ and N = 1, 4, 6, 10, 15, 20 are obtained, and the corresponding eight mass levels of positive parity are derived as functions of the three parameters and of the spin and other quantum numbers for $N_0 = 4$ and N = 1, 4, and 6 only. Agreement (3 parts in 1200) with the observed masses of Ξ^0, Ξ^-, Σ^0, Σ^+, Y^+, p, Δ^-, Δ^+ is obtained. The transitions between principal levels $[N_0,N]$ as well as within the spin multiplets of a given level are briefly described. The Lorentz-invariant generators for the group SU(2) constructed in terms of the generators of the U(3,1) and the Poincare group are used as a space-time isospin group. Finally, in the limit $\rho = \infty$ all masses, for any supermultiplet $[N_0,N]$, coalesce into the same mass m (one of the parameters of the theory), and the wave equation reduces to a Dirac-type equation for half-integral spin ($N_0 = 4$), or to a Kemmer-type equation for integral spin ($N_0 = 5, 10$), depending on the representation of G. (auth)

30548 PHASE OF η_{00} AND THE INVARIANCES CPT AND T. Schubert, K. R.; Wolff, B.; Chollet, J. C.; Gaillard, J.-M.; Jane, M. R.; Ratcliffe, T. J.; Repellin, J.-P. (CERN, Geneva). Phys. Lett., 31B: 662-5(11 May 1970).

The decay amplitude $\epsilon_0 = \frac{2}{3}\eta_{+-} + \frac{1}{3}\eta_{00}$ is decomposed into a CPT-conserving, T-violating part ϵ, and a T-conserving, CPT-violating part $\tilde{\delta}$. The measurement of the phase of η_{00} together with other results on K^0 decays yield: Re $\epsilon = (1.68 \pm 0.30) \times 10^{-3}$, Im $\epsilon = (1.45 \pm 0.30) \times 10^{-3}$, Re $\tilde{\delta} = (0.07 \pm 0.43) \times 10^{-3}$, and Im $\tilde{\delta} = (-0.30 \pm 0.45) \times 10^{-3}$. (auth)

Applications (Strong)

30549 (NP-18241) CONSISTENCY CONDITIONS BETWEEN SU_3 AND EXCHANGE DEGENERACY. Rimpault, M.; Salin, Ph. (Bordeaux Univ. (France). Laboratoire de Physique Theorique). Mar 1970. 21p. Dep. CFSTI (U. S. Sales Only).

Nonexotic solutions for hadron-hadron scattering amplitudes compatible with exact SU_3 symmetry and exchange degeneracy are presented and discussed. It is shown that there exist dual solutions, i.e., solutions which reproduce themselves under crossing from one channel to the others. The physical consequences predicted by these solutions are also investigated. (France)

Field Theories

General

30550 METRICS ON TEST FUNCTION SPACES FOR CANONICAL FIELD OPERATORS. Hegerfeldt, Gerhard C.; Klauder, John R. (Bell Telephone Labs., Murray Hill, N. J.). Commun. Math. Phys.; 16: 329-46(1970).

In a canonical field theory, the field $\Phi(f)$ and momentum $\pi(g)$ are assumed defined for test functions f and g which are elements of linear vector spaces $\mathcal{V}_\Phi$ and $\mathcal{V}_\pi$, respectively. Generally, the continuity of the map onto the unitary Weyl operators U(f), V(g) is taken as ray continuity, the barest minimum to recover the field operators as their generators, i.e., $U(f) = e^{i\Phi(f)}$, $V(g) = e^{i\pi(g)}$. This leaves open the question of whether any wider continuity properties follow and what form they would take. It is shown that much richer continuity properties do follow in a natural fashion for every cyclic representation of the canonical commutation relations. In particular, it is shown that the test function space may be taken as a metric space, that the space may be uniquely completed in this topology, and that the map into the unitary Weyl operators is strongly continuous in this topology. The topology induced by this metric is minimal in the sense that it is the weakest vector topology for which the maps $f \to U(f)$, $g \to V(g)$ are strongly continuous. An expression for a suitable metric can easily be given in terms of a simple integral over a state on the Weyl operators. (auth)

30551 INVARIANT EQUATIONS FOR NONLINEAR FIELDS AND CONSERVATION LAWS. Markovski, B. L.; Stoyanov, D. Ts. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 1: 337-49(Dec 1969). (In Russian).

The properties of nonlinear representations of Lie groups are investigated, which make it possible to obtain invariant equations for the fields transforming under these representations. The corresponding conserved quantities are also obtained. (auth)

30552 DEGENERATION OF VACUUM AND SPURION FORMALISM FOR THE ROTATION GROUP. Vasil'ev, A. N.; Yakubov, A. F. (Leningrad State Univ.). Teor. Mat. Fiz.; 1: 182-6(Nov 1969). (In Russian).

It is shown that in the case of the vacuum being degenerated with respect to the rotation group, the arising additional (with respect to the field) degrees of freedom can be described by means of introducing creation–annihilation operators for the spurion (as was the case for the gauge group considered previously). (auth)

Quantum Field Theory

Refer also to abstracts 30486 and 30602.

30553 (DESY-70/15) ON PARASTATISTICS. Druehl, K.; Haag, R.; Roberts, J. E. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr 1970. 27p. Dep. CFSTI (U. S. Sales Only).

The physical content of a para-Fermi field theory is analyzed from the point of view of its local observables. The parafield theory leads to parastatistics only for special choices of the observable algebra, and only then gives a complete description of the relevant physical states. On the other hand there is always a physically equivalent description in terms of a certain number of ordinary Fermi fields from which the observables are selected by a (in general non-Abelian) gauge group. Thus one can always achieve a reduction to Fermi statistics by considering a system with different particle types which are distinguished by hidden (unobservable) quantum numbers. (auth)

30554 (IS-T-340) SOME APPLICATIONS OF COHERENT STATES IN QUANTUM ELECTRODYNAMICS. Nordstrom, Dennis Leland (Ames Lab., Iowa). Feb 1970. Contract W-7405-eng-82. 77p. Dep. CFSTI.

Thesis.

An alternative treatment of the infrared divergence problem in quantum electrodynamics is described. A diffraction dissociation approximation is used to show that the spurious infrared divergence is due to the self-field of the electron and only arises from an incorrect application of the Feynman–Dyson perturbation theory due to the uncountable number of soft photons present in a scattering process. The infrared divergences are then removed by modifying the definition of the asymptotic electron states to include soft-photon contributions in order that the low-frequency portion of the Fourier transformed self-field of the electron may be cancelled. The soft-photon contributions are incorporated into the asymptotic electron states by letting them be direct products of coherent photon states and electron occupation number states and are eventually shown to belong to a Hilbert space unitarily inequivalent to the occupation number space. The amount of the self-field that is cancelled depends on the momentum spread given the modified electron wave packet state and may be chosen to correspond with experiment. The cancellation is made and the parametrization of the coherent states is determined by demanding that the expectation value of the quantized electromagnetic free-field for the modified wave packet state cancels the classical self-field generated from the expectation value of the asymptotic current operator. The resulting coherent state is found to have the same singularity structure in its parametrizing function as obtained previously thus eliminating the infrared divergences for any scattering process. (auth)

30555 (NYO-3829-49) THE QUANTIZATION OF $m^2 < 0$ FIELD EQUATIONS. Schroer, Bert (Pittsburgh Univ., Pa. Dept. of Physics). Apr 1970. Contract AT(30-1)-3829. 17p. Dep. CFSTI.

We construct the smallest causal covariant field theory in which the Wigner $m^2 < 0$ representations of the Poincaré group can be imbedded. "Jelly"-states lead to a causal screening of "tachyon"-states. (auth)

30556 TACHYON PHOTONS IN THE VANISHING WAVE ASSOCIATED WITH TOTAL REFLECTION. Costa de Beauregard, Olivier (Paris Univ.). Compt. Rend., Ser. B; 270: 773-6(23 Mar 1970). (In French).

A complex de Broglie group velocity $u^x = n\alpha c > c$, $u^y = j(n^2\alpha^2 - 1)^{1/2} c$, $u^z = 0$ ($u = c$), corresponds to the complex propagation vector of the Fresnel vanishing wave of angular frequency ω, $k_t^x = k^x = n\alpha\omega/c > \omega/c$, $k_t^y = j(n^2\alpha^2 - 1)^{1/2}\ \omega/c$, $k_t^z = 0$ ($k_t = \omega/c$).

The stimulated absorption or emission of momentum-energy quanta of the vanishing wave by particles described by a "Darwin globule" of small dimensions as compared with $[(n^2\alpha^2 - 1)^{1/2}\,\omega]^{-1}$, is equivalent to that of tachyon photons of energy $\hbar\omega$ and momentum $\hbar k_t^x = n\alpha\hbar\omega/c > \hbar\omega/c$. (France)

30557 THEORIES WITH DIPOLE GHOST: CAN THEY REALLY BE INTERPRETED. Nagy, K. L. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 28: 245-9 (1970).

Some arguments based on a simple model are given to show that whenever the question in the title is put forward, it means that in reality the dipole character has already been lost. (auth)

30558 NORMAL PRODUCTS IN THE THIRRING MODEL. Lowenstein, John H. (Univ., Sao Paulo, Brazil). Commun. Math. Phys.; 16: 265-89(1970).

The short-distance behavior of products of fields is studied in the Thirring model of a self-interacting, massless, spinor field in two dimensions. One is able to construct normal products which share most of the convenient properties of the free-field Wick products. A modified form of Wilson's expansion formula is verified. The original formulation of Wilson's hypothesis is seen to hold to every finite order in the coupling constant, but fails in the exact solution of the model for sufficiently strong coupling. (auth)

30559 DEFINITION OF THE VECTOR-PARTICLE CURRENT AND POLARIZATION OPERATOR IN THE YANG-MILLS THEORY. Altukhov, A. M.; Khriplovich, I. B. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz.; 11: 902-11(Apr 1970). (In Russian).

The Yang-Mills field is considered in the radiation gauge. The Hamiltonian is written as an explicit function of independent canonical variables in form of a series in the coupling constant. Considering the Feynman graphs resulting from the Hamiltonian a simple explanation is obtained of the necessity to introduce additional graphs with fictive particles under covariant description of the Yang-Mills field. A correct definition of the self-interaction current for the Yang-Mills particles is given with account of the Schwinger separation of the arguments. The polarization operator for the Yang-Mills field is calculated with this definition to the second order in the coupling constant. It is shown that no mass of the Yang-Mills field arises in the perturbation theory. (auth)

30560 SPACE-TIME POSITION OPERATORS. Broyles, A. A. (Univ. of Florida, Gainesville). Phys. Rev., D; 1: 979-88(15 Feb 1970).

A formalism is presented giving the development of $\psi(\bar{x})$ in time with the interpretation that $\psi(\bar{x})$ is the probability amplitude for observing an event at a space-time point $\bar{x}$. No properties other than the four space-time coordinates are associated with an event. A Hilbert space is defined in which $\psi(\bar{x})$ is the result of a scalar product. The space-time position operators defined in this Hilbert space have no association with particle properties, such as mass. These operators cannot be defined in the Hilbert space spanned by solutions of a Schroedinger equation, since the operators lead out of the Hilbert subspace belonging to a given mass. It is shown that state vectors in Hilbert space that are eigenvectors of $P_\mu P^\mu$ produce position amplitudes satisfying the Klein-Gordon equation. The relation between this Hilbert space and the one introduced by Dirac is discussed. Spin is not considered. (auth)

30561 GEOMETRICAL DERIVATION OF THE CONSERVATION LAWS. Alderman, Jerry L.; Bergmann, Otto (George Washington Univ., Washington, D. C.). J. Math. Phys. (N. Y.); 11: 1639-44(May 1970).

Conservation laws which are customarily obtained by invoking the invariance of a Lagrangian density under the transformations of some intrinsic symmetry group may be given a completely geometrical treatment within the context of the theory by Yang and Mills. The formalism is extended from unitary transformations to general linear transformations and the concepts of parallel transfer, covariant differentiation, and intrinsic curvature tensor are discussed. Conservation laws follow from the assumed invariance of the Lagrangian under parallel transfer defined with a general affine connection which is a direct sum of intrinsic and space-time affinities. Conservation of generalized charge is a consequence of the arbitrariness of that part of the affinities which operates in the intrinsic space, and conservation of energy and momentum is related to the arbitrariness of the part of the affinities which operates on the space-time indices. Some comments on Palatini's derivation of Einstein's equation of general relativity are made. (auth)

30562 ANALYTICITY OF THE SCATTERING AMPLITUDE IN FIELD THEORIES WITH EXPONENTIALLY DECREASING COMMUTATORS IN THE SPACELIKE REGION. Dobson, Peter N. Jr. (Univ. of Hawaii, Honolulu). J. Math. Phys. (N. Y.); 11: 1750-8 (May 1970).

The implications of weakening the axiom of local commutativity to a condition of exponential decrease are studied. A strong operator limit on the behavior of the commutator for large spacelike separations leads to fields which are almost local in the sense of Haag. A further condition on the spatial behavior of matrix elements of the commutator is introduced, which leads to analyticity of the elastic scattering amplitude at fixed momentum transfer in a striplike region in the complex-energy plane. (auth)

30563 NEW APPROACH TO RENORMALIZATION IN QUANTUM FIELD THEORY. Gachok, V. P. (Inst. for Theoretical Physics, Kiev). Phys. Lett., 31B: 651-4(11 May 1970).

A new representation of the creation and annihilation operators is built, which realizes the momentum cut-off of the causal functions of the theory and establishes a connection between the regularizations in both the Hamiltonian method and perturbation theory. (auth)

30564 WIGHTMAN FORMULATION FOR NONLOCALIZABLE THEORIES. II. THEORY OF ASYMPTOTIC FIELDS AND PARTICLES. Iofa, M. Z.; Fainberg, V. Ya. (Lebedev Inst. of Physics, Moscow). Teor. Mat. Fiz.; 1: 187-99(Nov 1969). (In Russian).

It is shown that in the nonlocalizable and consequently nonmicrocausal field theories where Wightman functions increase exponentially in momentum space and satisfy the quasilocality condition it is possible to construct the theory of asymptotic fields and particles, i.e., to prove the existence of the unitary CPT-invariant S-matrix. (auth)

30565 ALGEBRAIC STRUCTURE OF THE LOCAL FIELD THEORY WITH THE FINITE MULTIPLICITY OF VACUUM DEGENERATION. Vasil'ev, A. N. (Leningrad State Univ.). Teor. Mat. Fiz.; 1: 305-17(Dec 1969). (In Russian).

It is shown that the Wightman functional, which satisfied all usual axioms and generates the representation with the finite-dimensional vacuum subspace, can be represented in a unique way as a mixture of pure functionals corresponding to theories with unique vacuum. (auth)

30566 ASYMPTOTIC STATES IN QUANTUM FIELD THEORY. Slavnov, D. A. (Moscow State Univ.). Teor. Mat. Fiz.; 1: 329-36(Dec 1969). (In Russian).

The asymptotical in- and out-states are constructed in the framework of the S-matrix approach to the quantum field theory. The basic object of this approach is the S-matrix depending on the switching-off interaction function. (auth)

30567 INVARIANT VARIATIONAL PROBLEMS AND THE CONSERVATION LAWS (REMARK ON NOETHER'S THEOREM). Ibragimov, N. Kh. (Inst. of Hydrodynamics, Novosibirsk, USSR). Teor. Mat. Fiz.; 1: 350-9(Dec 1969). (In Russian).

The generalization of Noether's theorem in conservation laws for invariant variational problems is given. As an example all conservation laws for the Dirac equation are found. (auth)

30568 CANONICAL VARIABLES IN THE PHYSICS OF INFINITE SYSTEMS. Zav'yalov, O. I.; Sushko, V. N. (Inst. of Mathematics, Moscow. All-Union Scientific Research Inst. of Sources of Currents, Moscow). Teor. Mat. Fiz.; 1: 153-81 (Nov 1969). (In Russian).

The main results of the mathematical theory of canonical variables for systems with infinitely many degrees of freedom are discussed. The applications of these results to statistical mechanics and quantum field theory are considered. (auth)

30569 NEW COVARIANT APPROACH IN THE THEORY OF THE SPINOR FIELD. Gorbatenko, M. V.; Romanov, Yu. A. (Lebedev Inst. of Physics, Moscow). Teor. Mat. Fiz.; 1: 222-37 (Nov 1969). (In Russian).

A covariant theory of the spinor field which differs in its initial ideas and results from the spinor theory of Riemanian space using the tetrapode formalism is considered. The theory under consideration remains nonlinear even when a space curvature can be neglected. In the linear approximation the theory allows one to obtain the Dirac equation for some generalized wave function. This wave function contains electron states and also additional states which are interpreted as neutrino states. (auth)

30570 LAMB SHIFT AND NONLINEAR ELECTRODYNAMICS. Arbuzov, B. A. Teor. Mat. Fiz.; 1: 238-41(Nov 1969). (In Russian).

The difference between the theoretical and experimental data

on the Lamb shift can be explained in the framework of nonlinear electrodynamics with the elementary length $l_0 \simeq 10^{-14}$ cm. (auth)

30571 KEMMER–DUFFIN EQUATIONS IN THE FIVE-DIMENSIONAL MINKOWSKI SPACE. Krivskii, I. Yu.; Romanko, G. D.; Fushchich, V. I. (Inst. of Problems in Mathematics, Kiev. Uzhgorod State Univ., USSR. Inst. of Mathematics, Kiev). Teor. Mat. Fiz.; 1: 242-50(Nov 1969). (In Russian).

An exhaustive analysis of the Kemmer–Duffin equations in five-dimensional Minkowski space was made. The concrete realisation of generators of the nonuniform de-Sitter group is found, which is related to 6-, 15- and 20-dimensional square matrices β_μ of Kemmer–Duffin–Petiau algebra in five-dimensional space. An effective method is proposed for the realizations of all representations of Kemmer–Duffin–Petiau algebra in spaces of arbitrary dimension. (auth)

30572 EXTENDED LOCALITY AND OTHER PROPERTIES OF LOCAL W* ALGEBRA. Khoruzhii, S. S. (Inst. of Mathematics, Moscow). Teor. Mat. Fiz.; 1: 95-100(Oct 1969). (In Russian).

In the framework of algebraic quantum field theory of the Haag–Araki type a number of propositions are proven about the properties of the extended locality condition. The strictly axiomatic proof of the duality theorem is also given. (auth)

30573 ASYMPTOTIC BEHAVIOR OF GREEN FUNCTIONS FOR SOME NONRENORMALIZABLE FIELD-THEORETIC MODELS. Atakishiev, N. M. (Inst. of Mathematics, Moscow). Teor. Mat. Fiz.; 1: 60-6(Oct 1969). (In Russian).

The asymptotic behavior of solutions of an n-order differential equation is investigated. The equation, considered with a suitable choice of n and parameters b_j, is satisfied by Green's functions of certain models of nonrenormalizable field theory. (auth)

30574 NOTE ON THE MASS SPECTRUM OF INFINITE-DIMENSIONAL RELATIVISTIC WAVE EQUATIONS. Komar, A. A.; Slad, L. M. (Lebedev Inst. of Physics, Moscow). Teor. Mat. Fiz.; 1: 50-9(Oct 1969). (In Russian).

The states described by infinite-component relativistic wave equations are investigated from the viewpoint of spin dependence on their masses. It is shown to be possible for the linear equations of Gelfand–Yaglom type under the additional restrictions to obtain the branches of the mass spectrum, increasing with the spin, together with the usual decreasing branches. It is possible also to remove the decreasing branches completely by means of a certain generalization of the structure of the linear relativistic wave equation. These conclusions are illustrated by examples. (auth)

30575 VARIATIONAL PRINCIPLE AND NONCONSERVING OPERATORS. Polubarinov, I. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 1: 34-49(Oct 1969). (In Russian).

A variational principle is applied for the construction of nonconserving operators in field theory. The operators are induced by means of infinitesimal transformations, which do not leave the Lagrangian invariant. The nonconserving operators and their equations which correspond to translational, conformal and phase transformations are constructed as an example. The nonconserving operators induced by gauge transformations are also obtained. (auth)

30576 FEYNMAN INTEGRAL FOR SINGULAR LAGRANGIANS. Faddeev, L. D. (Inst. of Mathematics, Leningrad). Teor. Mat. Fiz.; 1: 3-18(Oct 1969). (In Russian).

The generalization of the Feynman functional integral, useful for the quantization of the mechanical system with the singular Lagrangian, is obtained. The quantization of the Yang–Mills field theory is considered as an application. (auth)

30577 TIME EVOLUTION OF QUANTIZED FIELDS WITH BOUNDED QUASI-LOCAL INTERACTION DENSITY. Streater, R. F.; Wilde, I. F. (Bedford Coll., London). Commun. Math. Phys.; 17: 21-32(1970).

The proof by Guenin that the time evolution is an automorphism group of the local algebras, if the interaction Hamiltonian is a space-integral of a bounded local density with finite range, is extended to arbitrary dimension. (auth)

Gravitation and General Relativity

30578 (AD-684586) GENERAL RELATIVITY. Final Technical Report. Komar, Arthur B. (Yeshiva Univ., New York. Dept. of Physics). 27 Feb 1969. 6p. (AFOSR-69-608-TR). CFSTI.

Research which was directed toward the development of a quantum theory of gravitation is summarized. The result of work on the superenergy tensor, the Hamilton–Jacobi theory of general relativity, Bohr's correspondence principle, and other problems in quantum field theory are summarized. (auth)

30579 A SOLUTION OF THE EINSTEIN EQUATIONS WITH A MAGNETIC FIELD. Mas, Luis (Paris Univ.). Compt. Rend., Ser. A; 270: 837-40(1 Apr 1970). (In French).

The Kerr-Schild space-time with an electromagnetic field, and the particular case of a magnetic field, the two eigenvectors of which are two principal vectors of the Weyl tensor, are studied. (France)

30580 UNICITY THEOREM FOR THE EINSTEIN–LIOUVILLE EQUATIONS. Choquet-Bruhat, Yvonne (Paris Univ.). Compt. Rend., Ser. A; 270: 728-30(16 Mar 1970). (In French).

A theorem of local unicity and stability for the solution of a Cauchy problem related to the integro-differential nonlinear system of the Einstein–Liouville equations is demonstrated, using energetic inequalities. A theorem of geometric unicity is deducec from it. (France)

30581 BEHAVIOR OF ELEMENTARY PARTICLES IN A GRAVITATIONAL FIELD. Stanyukovich, K. P. Probl. Teor. Gravitatsii Elem. Chastits; No. 2, 82-95(1969). (In Russian).

An investigation was made of the effect of fluctuations of particles on space-time characteristics. It is possible to introduce the gravitational interaction radius, which represents the dimension of the interaction region of elementary particles in the gravitational field. Such a radius is "indestructible" because of the universal characteristic of the gravitational interaction. The radius depends on the Planck constant h, gravitational constant G, and the speed of light in a vacuum c: $L = \sqrt{Gh/C^3} = 10^{-33}$cm. Since the relative fluctuations of metrics for elementary particles are $L/r_0 = 10^{-20}$ (r_0—nucleon radius), which significantly exceeds $r_g/r_0 = 10^{-40}$ (r_g—nucleon gravitational radius), then, in the field theory it is possible to disregard the space curvature caused by the natural Schwarzschild field and to consider only the gravitational fluctuations of metrics of the quasi-Euclidean space. It is shown that fluctuations of particle positions in the gravitational field "curve" the initial quasi-Euclidean space and reduce it to a Riemannian field in the first approximation. (JPRS)

30582 SCALAR-TENSOR THEORY IN CANONICAL FORM. I. THE QUESTION OF MACH'S PRINCIPLE. Toton, Edward T. (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.); 11: 1713-24(May 1970).

By first casting the scalar-tensor theory into canonical form, the constraint equations are obtained from which it is possible to discuss the self-energy problem of the neutral particle and the electron. With the assumptions of Minkowski space and a constant scalar field as boundary conditions at infinity, it is shown by variational arguments that the inertia of these objects is unchanged from the corresponding general relativity values. Accordingly, if the boundary value of the scalar is altered by a change of matter at infinity, the mass of the electron is unchanged. From this point of view, the scalar-tensor theory is no more compatible with Mach's principle than is general relativity. (auth)

30583 SURFACE LAYER IN GENERAL RELATIVITY AND INTEGRAL FORM OF FIELD LAW. Gupta, Amritava (Calcutta Univ.). J. Math. Phys. (N. Y.); 11: 1725-9(May 1970).

Assuming that the metric tensor g_{ij} depends on a continuous parameter ϵ, Einstein's field equations of general relativity are written in the form of a divergence equation. The theory of the surface layer in general relativity is then worked out. Finally, an integral flux law is proposed from which both the field equations and the boundary conditions for a surface layer can be deduced. (auth)

30584 SYMMETRIC DIRAC BRACKET IN CLASSICAL MECHANICS. Franke, Wilhelm H.; Kalnay, Andres J. (Univ. Nacional de Ingenieria, Lima). J. Math. Phys. (N. Y.); 11: 1729-34(May 1970).

It is known that, in classical systems that have second-class constraints which relate the canonical coordinates and momentum, the ordinary skew-symmetric Poisson bracket must be replaced by the skew-symmetric Dirac bracket. It is also known that in the process of quantization of such systems, the Dirac bracket replaces the Poisson bracket in its correspondence with the quantum commutators. The symmetric partner of the Dirac bracket, is obtained which is of interest not only to classical mechanics but also in regard to the quantization procedure; i.e., the quantization rules for systems which are restricted by second-class constraints such that the commutation rules involve anti-commutators (instead of commutators, as in certain fields with Fermi–Dirac statistics) can be given in terms of this new symmetric bracket. This symmetric bracket is related to the Poisson–Droz–Vincent symmetric bracket. (auth)

30585 LORENTZ-INVARIANT GRAVITATIONAL PERTURBATIONS AND THE EVALUATION OF GENERALIZED GREEN'S FUNCTIONS. Goenner, Hubert (Temple Univ., Philadelphia). J. Math. Phys. (N. Y.); 11: 1645-55(May 1970).

The Lorentz-invariant perturbation theory of classical nonlinear field theories, notably the fast-motion approximation for a system of gravitationally interacting particles, is used to illustrate the appearance of generalized Green's functions (GGF's) in physics. The (retarded) GGF's are defined as the convolution of the usual (retarded) Green's function with certain other linear functionals. A manifestly Lorentz-invariant technique for the evaluation of the convolution integral is described and applied to two important classes of GGF's. Time-symmetric GGF's are also discussed briefly. The technique exhibited provides the tools for the calculation of the higher-order approximations in a Lorentz-invariant perturbational approach to the classical n-body problem. (auth)

30586 GROUPS OF CURVATURE COLLINEATIONS IN RIEMANNIAN SPACE-TIMES WHICH ADMIT FIELDS OF PARALLEL VECTORS. Katzin, Gerald H.; Levine, Jack; Davis, William R. (North Carolina State Univ., Raleigh). J. Math. Phys. (N. Y.); 11: 1578-80(May 1970).

By definition, a Riemannian space V_n admits a symmetry called a curvature collineation (CC) if the Lie derivative with respect to some vector ξ^i of the Riemann curvature tensor vanishes. It is shown that, if a V_n admits a parallel vector field, then it will admit groups of CC's. It follows that every space-time with an expansion-free, shear-free, rotation-free, geodesic congruence admits groups of CC's, and hence gravitational pp waves admit such groups of symmetries. (auth)

30587 MEASURING THE GRAVITATIONAL INTERACTION OF ELEMENTARY PARTICLES. Beall, E. F. (Univ. of Maryland, College Park). Phys. Rev., D; 1: 961-78(15 Feb 1970).

An approach to the measurement of static gravitational couplings is discussed. A plausible mathematical treatment of the nongravitational interactions of particles in the presence of a small, constant, classical tensor field without the assumption of universal coupling to the field is outlined. Some nonstandard features, principally the breakdown of strict Lorentz covariance, are pointed out. Calculations based on this formalism, or, alternatively, on simple energy-momentum conservation, indicate that some particle processes which are forbidden if the coupling to the tensor field is universal are allowed if it is not. The processes considered in some detail are spontaneous emission of a photon by a free particle, spontaneous photoproduction of a particle-antiparticle pair, and spontaneous neutrino decay. These occur under certain conditions involving the energies and the coupling constants to the tensor field. The tensor field is identified with the local gravitational field and rates are estimated. Certain existing data on the absence of such reactions give evidence that the gravitational coupling of the muon in particular is equal to that of the photon to within parts per ten thousand, and that all particles with mc^2 less than a few GeV, excepting possibly the neutrinos and the graviton itself, have gravitational coupling which is at most the normal amount—to varying degrees of accuracy. The latter result is subject to an assumption that the algebraic sign of the local gravitational field is what one expects on intuitive grounds. (auth)

30588 ELASTICITY THEORY IN GENERAL RELATIVITY. Hernandez, Walter C. Jr. (Naval Research Lab., Washington, D. C.). Phys. Rev., D; 1: 1013-18(15 Feb 1970).

An elasticity theory in general relativity is formulated and includes a measure of the strain which is identical to the classical concept. The theory is developed essentially by generalizing the classical elasticity theory. The physical interpretation of the work is simplified by retaining the three-dimensional form of the classical quantities. As a further aid to understanding the theory, some of the thermodynamics and the weak-field limit are studied. As part of the investigation the classical theory is reformulated so that there is no explicit dependence on the displacement u. The resulting equations near a strong similarity to the general-relativistic field equations when they are cast in a manner called the (3 + 1) form. (auth)

30589 CLASS OF ALGEBRAICALLY SPECIAL PERFECT FLUID SPACE-TIMES. Wainwright, J. (Univ. of Waterloo, Ont.). Commun. Math. Phys.; 17: 42-60(1970).

Solutions of the Einstein field equations are considered subject to the assumptions that (1) the source of the gravitational field is a perfect fluid, (2) the Weyl tensor is algebraically special, (3) the corresponding repeated principal null congruence is geodesic and shearfree. If in addition, the repeated principal null congruence is nonexpanding, it follows that the twist of this congruence must be nonzero (for a physically reasonable fluid). The general line element subject to this additional restriction is derived. Furthermore, it is shown that all solutions of the Einstein field equations which satisfy (1) and exhibit local rotational symmetry, necessarily satisfy (2) and (3). (auth)

Scattering Theory

Refer also to abstracts 30493, 30564, and 30940.

30590 (CONF-690521-, pp 689-714) A PRACTICAL APPROACH TO POLE EXTRAPOLATION. Wolf, Guenter (Stanford Linear Accelerator Center, Calif.).

It is shown that reliable results can be expected for on-mass-shell scattering cross sections using the OPE model when the Benecke-Dürr parametrization is used for the pole extrapolation. The $\pi^-p \to \pi^-\pi^+n$ interaction is considered as an example. The OPE model with the Benecke-Dürr parametrization is then applied to the following reactions: $\bar{p}p \to \bar{\Delta}^{--}\Delta^{++}$, $pp \to \Delta^{++}n$, $\pi^+p \to \Delta^{++}\rho^0$, $\pi^-p \to n\rho^0$. (L.B.S.)

30591 (SU-1206-221) CONDITIONS FOR REGGE BEHAVIOUR OF AN ABSOLUTELY CONVERGENT VENEZIANO SERIES. Frampton, P. H.; Gardiner, C. W. (Syracuse Univ., N. Y. Dept. of Physics). Mar 1970. 29p. (NYO-3399-221). Dep. CFSTI.

The conditions for the validity of a Regge asymptotic expansion of a scattering amplitude, A(s,t), is investigated which can be written in the form of an absolutely convergent series as $A(s,t) = \Sigma_{l,h=0}^{\infty} C_{lh}[\Gamma(l + h - S)\Gamma(l + h - T)/l!(\Gamma(l + 2h - S - T)]$ where $S = \alpha(s)$, a real linear Regge trajectory, and T is similarly defined. It is shown that a sufficient condition for Regge behavior when $|S| \to \infty$ at fixed $|T|$, with $|\mathrm{Arg}(S)| < \pi$, is that the function $F_1(z,T) = \Sigma_{l,h=0}^{\infty} C_{lh}[\Gamma(l + h - T)/l!\Gamma(h - T)]\, z^{l+h}(1 - z)^h$ be analytic in $|z| < 1$ and at $z = 1$. A corresponding necessary condition is analyticity in $|z| < 1$. A sufficient condition for Regge behavior at fixed u is that the function $F_2(z,S + T) = \Sigma_{l,h=0}^{\infty} C_{lh}[\Gamma(2l + 2n - S - T)/l!\Gamma(l + 2h - S - T)]\, z^{l+h}$ be analytic for all z except real z satisfying $\frac{1}{4} < z < \infty$. A corresponding necessary condition allows singularities in the closed interval $\frac{1}{4} \le z < \infty$. Finally, it is shown that the sufficient condition for Regge behavior of fixed t is sufficient to guarantee that A(s,t) is a meromorphic function, the residues of whose poles are obtained by summing the residues of the corresponding pole in each term of the series. (auth)

30592 SOLUTION OF THE UNITARITY CONDITION FOR ELASTIC SCATTERING AMPLITUDE AT HIGH ENERGIES. Savrin, V. I.; Tyurin, N. E.; Khrustalev, O. A. (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 11: 880-8 (Apr 1970). (In Russian).

The unitarity condition is solved for the elastic scattering amplitude at high energies, at $-t \ll s$, provided the contribution from inelastic processes and the pure elastic scattering phase shift are fixed. The present method is compared with the quasi-potential approach. (auth)

30593 HIGH-ENERGY SCATTERING MODEL WITH BREAKING OF THE POMERANCHUK THEOREM. Ansel'm, A. A.; Danilov, G. S.; Dyatlov, I. T.; Levin, E. M. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 11: 896-901(Apr 1970). (In Russian).

Examples are presented for a possible violation of the Pomeranchuk theorem with the interaction radius increasing as the energy logarithm. The examples satisfy general principles of the theory (analyticity, crossing symmetry, unitarity). The diffractional model with the s-channel partial wave amplitudes $\sim 1/\ln s$ is discussed in detail. The diffractional model with total absorption and the cross section $\sigma_{tot} \sim \ln^2 s$ is also discussed. Singularities of the crossing partial waves are considered. (auth)

30594 VARIATIONAL BOUNDS ON SCATTERING AMPLITUDES FOR UNPHYSICAL ENERGIES. Rosenberg, Leonard (New York Univ., Bronx). Phys. Rev., D; 1: 1019-21(15 Feb 1970).

The Kohn-type variational principle for the elements of the scattering matrix is derived in a form which displays the second-order error term explicitly. With the scattering energy taken to be a complex parameter, a calculable bound on the magnitude of this error term is obtained. This allows for a systematic improvement in the accuracy of the variational calculation. The motivation for this study lies in recent demonstrations that accurate analytic continuation to physical energies can in fact be performed. The applicability of this technique to the determination of the level-shift operator and the effective potential is pointed out. (auth)

30595 RELATIVISTIC PARTIAL-WAVE ANALYSIS IN TWO VARIABLES AND THE CROSSING TRANSFORMATION. Pajas, P. (Nuclear Research Inst., Czechoslovak Academy of Sciences, Rez, Czech.); Winternitz, P. Phys. Rev., D; 1: 1105-14(15 Feb 1970).

The properties with respect to the crossing transformation of previously suggested relativistic two-variable expansions are considered. Signature amplitudes with definite symmetries are introduced, and it is shown that if the total amplitude is an analytic function satisfying a subtractionless Mandelstam representation, and if the signature amplitudes are square-integrable functions (with a suitable measure) in the physical region of each channel, then two-variable expansions of one type can be continued into expansions of another type, from one channel into the other. The expansion coefficients, called Lorentz amplitudes, in both physical regions, carrying all the dynamics, are shown to be two separate pieces of a general analytic function of the complex angular momentum l. It is suggested that these analyticity properties should be made use of to relate low-energy and high-energy scattering data. (auth)

30596 n-POINT FUNCTIONS AND CURRENT ALGEBRA. Freedman, Daniel Z. (State Univ. of New York, Stony Brook). Phys. Rev., D; 1: 1133-40(15 Feb 1970).

It is shown that two proposals for the incorporation of currents in dual n-point functions are very unlikely to be correct because of anomalies in their factorization or level-structure properties. The amplitude proposed by Bander has infinitely degenerate Regge trajectories even at the leading level. Amplitudes constructed according to a prescription by Sugawara and Ohba have a richer spectrum than that of hadronic n-point functions and, even worse, are internally inconsistent in their factorization properties. Finally a set of dual functions for n external bosons is constructed, one vector current, and one scalar current which satisfy the Ward identities of a local vector-scalar current algebra. Only the scalar current has structure (pole-dominated) in these amplitudes. The vector current is structureless. Because of this simplification, the factorization inconsistency mentioned above does not apply, and it is very possible that a resonance-saturated current algebra which realizes essentially the Dashen–Gell-Mann program can be constructed from these amplitudes. (auth)

30597 DETERMINATION OF THE PHASE OF THE SCATTERING AMPLITUDE FROM THE DIFFERENTIAL CROSS SECTION. Gerber, R. B.; Karplus, M. (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 1: 998-1012(15 Feb 1970).

The unitarity relation of quantum scattering theory is studied to show how it can be utilized to obtain the phase of the scattering amplitude that corresponds to a given differential cross section. The main results are the following: (i) Provided the cross section is sufficiently small, repeated iterations of the unitarity equation yield a series which converges uniformly to the correct phase of the scattering amplitude. (ii) A modified iteration procedure can be introduced which provides a sequence of alternating upper and lower bounds on the phase of the scattering amplitude. Subject to a certain restriction on the magnitude of the cross section, the upper and the lower bounds so generated converge, respectively, from above and from below to the true value of the phase. (iii) A high-energy approximation to the unitarity relation, referred to as the small-phase approximation (SPA), is introduced. It is shown to be solvable by means of an iteration sequence, and upper and lower bounds to its solutions are constructed. (iv) Using some very crude approximations, the SPA equation for the phase of the scattering amplitude is solved explicitly in terms of the cross section. Since extremely oversimplifying assumptions are employed, this can be regarded only as a primitive model for a possible behavior of the exact solutions. The outline of these results is followed by a discussion of the practical applicability of the above methods for obtaining the phase of the scattering amplitude from the experimental cross section, in which their potential significance for atom-atom collision theory is stressed. (auth)

30598 COMMENTS ON THE JIN–MARTIN LOWER BOUND. Simon, Barry (Princeton Univ., N. J.). Phys. Rev., D; 1: 1240-1(15 Feb 1970).

An extremely simple derivation of the Jin–Martin bound is presented in a slightly weakened form. Explicitly, let $f^{AB\to AB}(s)$ be the spin-averaged forward-scattering amplitude for the process AB → AB [normalized by $\sigma_{tot} = 4\pi\,\mathrm{Im}f(s)/k\sqrt{s}$]. Then it is proved that there is a constant C and a sequence $s_n \to \infty$ such that either $f^{AB\to AB}(s_n) > Cs_n^{-2}$ (all n) or $f^{AB\to AB}(s_n) > Cs_n^{-2}$ (all n). The connection between allowable asymptotic behavior and the sign of the scattering length found by Jin and Martin is clarified. (auth)

30599 CONSERVATION THEOREM AND THE METHOD OF MOMENTS IN QUANTUM SCATTERING. Galindo, V. (TRW Systems Group, Redondo Beach, Calif.); Amitay, N.; Lee, Y. C. J. Math. Phys. (N. Y.); 11: 1691-2(May 1970).

The unitary condition, or the constraint imposed by the conservation of probability, is examined for certain approximate solutions to physical scattering problems. The unitary condition is shown to be preserved for an approximate nonrelativistic S matrix derived by a rather generalized moments method. The unitary condition, or conservation theorem, is shown to be satisfied independent of the accuracy of the approximate solution under certain specifically defined conditions. (auth)

30600 INVERSE SCATTERING PROBLEM FOR DIRAC PARTICLES. EXPLICIT EXPRESSIONS FOR THE VALUES OF THE POTENTIALS AND THEIR DERIVATIVES AT THE ORIGIN IN TERMS OF THE SCATTERING AND BOUND-STATE DATA. Corbella, O. D. (Univ., Rome). J. Math. Phys. (N. Y.); 11: 1695-1713(May 1970).

The inverse scattering problem for the Dirac equation with two central potentials (one a relativistic scalar, the other the fourth component of a 4-vector) is investigated. Exact expressions are obtained for the values of the two potentials and their derivatives at the origin, as a function of the scattering data and bound-state parameters of the particle and the antiparticle for one angular momentum. The consideration is limited to the case of S and P waves ($j = \frac{1}{2}$) and to potentials satisfying a restrictive condition; explicit expressions for the values of the two potentials and their first three derivatives at the origin are given. In the case with only one potential present (the usual Dirac equation), these relations provide explicit connections between the scattering and bound-state parameters for the particle and those for the antiparticle. For instance, an explicit and simple expression for the binding energy and for the corresponding normalization constant, in terms of the scattering phase shifts of the particle and of the antiparticle, is given in the case with only one bound state, say, for the particle, present (in S or P wave, with $j = \frac{1}{2}$). It is assumed that the two potentials are central, holomorphic, and satisfy the conditions $\int_a^\infty r^n |V_i(r)|dr < \infty$, i = 1, 2, n = 0, 1, 2. (auth)

30601 RELATION OF THE JUMPS THROUGH THE KINEMATIC AND ANOMALOUS CUTS WITH THE S MATRIX ON THE MASS SHELL. Troitskii, V. E.; Shirokov, Yu. M. (Moscow State Univ. Inst. of Mathematics, Moscow). Teor. Mat. Fiz.; 1: 213-21(Nov 1969). (In Russian).

The jumps through the kinematical and anomalous cuts for the matrix elements of the current operator $\langle 2|A(x)|0\rangle$ and $\langle 2|A(x)|2\rangle$ are connected with the S-matrix on the mass shell. (auth)

30602 VARIANT OF THE S-MATRIX THEORY. Slavnov, D. A. (Moscow State Univ.). Teor. Mat. Fiz.; 1: 200-12(Nov 1969). (In Russian).

The mathematical formulation of the postulates arising in Bogolyubov's approach to the quantum field theory is given. The local commutativity of the interpolating fields, the primitive causality, the stability of the vacuum and of the one-particle states are shown to follow from these postulates. (auth)

30603 AMPLITUDES WITH MANDELSTAM ANALYTICITY AND DUAL STRUCTURE. Friedman, M. H.; Nath, P.; Srivastava, Y. N. (Northeastern Univ., Boston). Phys. Rev. Lett.; 24: 1317-20(8 Jun 1970).

A general representation for scattering amplitudes is proposed which is crossing symmetric, satisfies Regge behavior and duality, and possesses double spectral functions. As the width parameter goes to zero, the resonance poles on the second sheet move onto the real axis and the amplitude reduces to the Veneziano model. Partial waves generated from this amplitude exhibit correct threshold behavior in both the real and imaginary parts. A generalization to more-point functions is also proposed. (auth)

Particle Accelerators

Refer also to abstracts 29471, 29596, 29809, 30440, and 30667.

30604 (CEA-N-1235) DUTY CYCLE OF ACCELERATORS. INFLUENCE ON NUCLEAR PHYSICS EXPERIMENTS. PILE-UP, RANDOM COINCIDENCES. Pottier, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1970. 22p. (In French). Dep. CFSTI (U. S. Sales Only).

The effects of the duty-cycle of accelerators on the experimental measurements are evaluated (pile-up, random coincidences). It is shown that, in almost all cases, a large duty cycle $\Delta T/T$ is to be preferred. Nevertheless, a short pulse duration ΔT is necessary when coincidence measurements are performed with a device of long resolution time and is useful when a counting is made after the beam pulse. (France)

30605 (CERN-70-11) DEPOLARIZATION OF A BEAM OF PROTONS ACCELERATED IN A SYNCHROCYCLOTRON. APPLICATION OF THE CALCULATIONS TO THE CERN SYNCHROCYCLOTRON. Besnier, Gilbert (European Organization for Nuclear Research, Geneva (Switzerland)). 7 Apr 1970. 51p. (In French). Dep. CFSTI (U. S. Sales Only).

The causes of depolarization of a proton beam accelerated in the CERN synchrocyclotron are precisely studied. The description of magnetic resonance in the synchrocyclotron, depolarization calculations for an analysis of the perturbations of the horizontal field in the CERN synchrocyclotron, and radial field effects of the electric cavity are covered. (J.F.P.)

30606 (CERN-Trans-69-33) THE ACCELERATING SYSTEM OF THE 1000-GeV CYBERNETIC PROTON ACCELERATOR. Antonov, Yu. N.; Vasil'ev, A. A.; Kurochkin, V. A.; Urlin, B. M. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated by A. T. Sanders and Revised by N. Mouravieff (European Organization for Nuclear Research, Geneva, Switzerland), from report NTD-688. 8p. Dep. CFSTI (U. S. Sales Only).

Basic parameters of the accelerating system of the 1000-GeV cybernetic proton accelerator are presented. A schematic of one of the ferrite-tuned cavities is given, and a block diagram of the accelerating system is included. (W.H.K.)

30607 (CERN-Trans-70-1) DAMPING OF COHERENT OSCILLATIONS OF A BEAM IN A STORAGE RING. II. SYNCHROTRON PERTURBATIONS. Derbenev, Ya. S.; Dikanskij, N. S. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translation of Russian Preprint 318. 23p. (In French). Dep. CFSTI (U. S. Sales Only).

The possibility is studied of inventing a universal method for damping coherent phase instabilities. This is done with the help of the radiation of coherent perturbations in a doubly coupled wave guide system. The edge effects on betatron motion are considered. It is emphasized that perfectly adapted plates can induce damping as well as oscillation instability of coherent phase. (J.F.P.)

30608 (CERN-Trans-70-2) METHODS OF FORMATION OF SECONDARY PARTICLES IN THE INTERNAL TARGETS OF THE IHEP ACCELERATOR. Gridasov, V. I.; Kardash, A. A.; Kurnaev, O. V.; Merker, E. A.; Mojzhes, L. L.; Myznikov, K. P.; Tarakanov, N. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by A. Golovanoff (CERN, Geneva, Switzerland), from a paper presented at a conference held at Erevan, 1969. 13p. (In French). Dep. CFSTI (U. S. Sales Only).

In order to extract particles in a given channel, a target is introduced at a certain time in the acceleration cycle at a point determined by the vacuum chamber. The channels of secondary particles of the IHEP accelerator present the peculiarity of working in a wide range of momenta. Several targets are provided for each channel. The formation of a beam of secondary particles of prolonged life, necessary for the counter method, is carried out with the help of slow targeting. A method of local orbit deformations is described for extending the possible interval for radial displacement of the beam. Also in order to excite orbit amplitude deformations the excitation of a supplementary field is described. (J.F.P.)

30609 (IPP-3/100) LASER-INDUCED EMISSION OF STRONG ELECTRON PULSES IN THE NANOSECOND RANGE. Siller, G.; Buechl, K.; Buchelt, E. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jun 1969. 20p. Dep. CFSTI (U. S. Sales Only).

The light of a Q-switched ruby laser (2.5 joule, 17 nsec) is focused on a tantalum target. Strong electron pulses up to one kiloampere are extracted from the surface. The pulse length in the nanosecond range can be determined by the length of a delay line used as voltage source for the extracting voltage. In additional experiments the charge carriers in the negative pulse were identified as really free electrons. This low-emittance high-density electron source is being developed for an electron-ring accelerator. (auth)

30610 (KFKI-70-9) INVESTIGATION OF Zr-T AEROSOL. Feher, I.; Biro, J. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1970]. 12p. Dep. CFSTI (U. S. Sales Only).

The tritium incorporation hazard presented by detached solid particles from zirconium-tritium targets for production of 14-MeV neutrons was studied. The aerosol parameters of the particles detached from the zirconium-tritium targets were studied and the inhalation hazard was evaluated from personnel and area contamination monitoring data. (W.H.K.)

30611 (LNF-70/8) TWO BEAM TRANSVERSE COHERENT INSTABILITY IN COLLIDING BEAM RINGS. Note No. 467. Renieri, A. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 9 Mar 1970. 22p. Dep. CFSTI (U. S. Sales Only).

The dynamics of the instability which appears in electron-positron or electron-electron storage rings when two beams are intersecting in the vacuum chamber are studied. (W.H.K.)

30612 (NAL-40) THE MAIN-ACCELERATOR PROTOTYPE OPERATES. Monthly Report of Activities, March 31, 1970. Cole, F. T. (National Accelerator Lab., Batavia, Ill.). 8p. Dep. CFSTI.

Prototype operation, construction progress, and the status of the linac, booster, main accelerator, and experimental facilities are outlined. (W.H.K.)

30613 (NP-18224) COMPARISON OF THE COST OF A "MISSING MAGNET" AND A "MISSING POWER"-VERSION FOR THE 250/500-GeV SYNCHROTRON LATTICE MR 29. Arendt, Friedrich (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Kernphysik). Oct 1969. 7p. Dep. CFSTI (U.S. Sales Only).

The first stage in building a synchrotron could be the construction of a machine with ½ the actual design energy. This may be achieved by leaving out one half of the magnets initially ("missing magnet") or by installing only ¼ of the power supply ("missing power"). For the case of the MR 29-lattice of the big European synchrotron, the relative advantages of both versions are discussed. It turns out that the overall cost (construction + running costs) is comparable for both types. (auth)

30614 (NP-18229) VARIABLE SUPERCRITICAL COUPLING FOR SUPERCONDUCTING ACCELERATOR STRUCTURE. Pack, Klaus (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Dec 1969. 71p. (In German). Dep. CFSTI (U. S. Sales Only).

The feasibility of different methods of measuring the coupling coefficients was investigated theoretically. It turns out that the power transmitted is most practical to determine high and low coupling coefficients. Experimental investigations concerned coupling systems with loops and holes. The result was that the loop system was not sufficient because the desired coupling coefficient ($\beta_{max} = 100$ for $Q_0 = 3 \cdot 10^6$) had not been achieved. By contrast, hole coupling turns out to be the better solution with $\beta_{max} = 0.1$ for $Q_0 = 4 \times 10^3$ which corresponds to $\beta_{max} = 100$ for $Q_0 = 4 \times 10^6$. With this hole coupling system the coupling coefficient can be varied by a factor of about 50. (auth)

30615 (NP-18230) INSTABILITY AND ACCEPTANCE FOR PARTICLE BEAMS IN LINEAR ACCELERATORS WITH BETWEEN-TANK FOCUSING. Passow, C. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Oct 1969. 47p. (In German). Dep. CFSTI (U. S. Sales Only).

In superconducting accelerators focussing lenses have to be inserted between the accelerating tanks, otherwise the influence of the magnetic fields deteriorates the superconducting properties of the surface. The problems of longitudinal and transversal stability of particle trajectories have been studied for such a system. It turns out that longitudinal and transversal instabilities occur for certain combinations of tank length and tank spacing. It is shown that a lower accelerating frequency provides longer accelerating tank sections. In addition a much higher acceptance can be achieved. (auth)

30616 INVESTIGATION OF A SOURCE OF He^{++} IONS. Valyi, L. (Central Research Inst. for Physics, Budapest). Nucl. Instrum. Methods; 79: 315-19(1970).

The investigation of the characteristic parameters of a radio-frequency source of helium ions is reported. The width of the energy spectrum, the mass and charge distributions of the ion beam were measured as a function of the gas pressure and the frequency of the field exciting the rf discharge in ^3He or ^4He gas. Beam currents of 1.5 μA of $^3He^{++}$ ions and of 240 μA of $^3He^{++}$, $^4He^+$ ions can be focused on the target of the analyzing magnet. The half-width of the energy spectrum of the analyzed ions is 40 eV for an extracting voltage of 6 kV. (32 references) (auth)

30617 STUDIES ON EXTRACTION EFFICIENCY AND ENERGY SPREAD FOR THE SIN RING CYCLOTRON. Tripard, G. E.; Joho, W. (Schweizerisches Institut fuer Nuklearforschung, Zurich). Nucl. Instrum. Methods; 79: 293-303(1970).

A Monte Carlo simulation of the internal beam of the SIN ring cyclotron was used to study the extraction process as a function of radius, orientation and thickness of the septum. The influence of the radial focussing frequency and internal beam quality on the extraction efficiency and energy spread is given special attention. An attempt was made to optimize the septum's geometry for minimum beam loss. An extraction efficiency of better than 90% for the SIN cyclotron is expected. (auth)

30618 REALIZATION OF A POLARIZED DEUTERON SOURCE FOR A SYNCHROCYCLOTRON. Kouloumdjian, J.; Feuvrais, L.; Hadinger, G.; Pin, B. (Institut de Physique Nucleaire, Lyon). Nucl. Instrum. Methods; 79: 192-6(1970). (In French).

A polarized deuton source has been mounted on the 28 MeV synchrocyclotron of the Lyon University. After a magnetic separation, the atomic beam is polarized by means of one or several electromagnetic transitions. The atoms are injected in the median plane of the accelerator and ionized by a plasma. The depolarization due to resonances during the acceleration and extraction has proved to be small. The intensity of the extracted beam is 5×10^7 particles/s. (auth)

30619 LIQUID HYDROGEN AND DEUTERIUM TARGETS IN CLOSED SYSTEM. Godin, A.; Montenon, M. (CEN, Saclay, France). Nucl. Instrum. Methods; 79: 349-52(1970). (In French).

A hydrogen target is described. The Joule–Thomson expansion is used to liquefy the gas. The high-pressure (180 atm) is obtained by a compressor. In such a manner the hydrogen stays in a closed system. A deuterium target is also described. The liquefaction of the deuterium is obtained by an exchanger at the temperature of liquid hydrogen. (auth)

30620 ELECTRONIC POSITION ENCODER. Van der Schueren, A.; Tetu, P.; Aebi, J. J.; Bernard, L.; Sartori, M. (CERN, Geneva). Electron. Ind. (Paris); No. 131, 69-74(Mar 1970). (In French).

The electronic position-encoder designed at the CERN allows the positioning of the moving elements of a linear accelerator. The study of this encoding unit applied to a moving mechanical system and intended to be controlled by a computer includes: the description of the angular position encoder, the analysis of the associated transcoding and monitoring circuits, and the examination of the system in relation with a computer for programming the different operations in various mechanical positions of the LINAC. The encoder cams designed to be suitable for different speeds are also described. (France)

30621 SIMPLE TECHNIQUE FOR ELECTRON LINAC BEAM PROFILE MEASUREMENT. Rodda II, J. L. (West Virginia Univ., Morgantown). Nucl. Instrum. Methods; 80: 333-8(1970).

An investigation was undertaken to develop a technique for measuring the electron beam size for acceptance tests on the Oak Ridge Electron Linear Accelerator (ORELA). Of several methods considered, a foil activation technique is believed to be sufficiently accurate, and yet uncomplicated. Considerations leading to a choice of foil material and thickness are presented. Copper and nickel foils activated in the Rensselaer Polytechnic Institute electron linac were sectioned, and the measured activities of the various sections were used to determine the radial profile of the electron beam. Theoretical calculations of the foil activities agreed well enough with the experimental results so as to be useful for estimating the expected activity. (auth)

30622 GRAPHICAL CALCULATION OF WAIST-TO-WAIST TRANSFER IN PARTICLE OPTICS. Luccio, A. U. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 80: 197-204 (1970).

A graphical method is described to calculate waist-to-waist transfer in thin-lens particle optics. Examples are given to show how the method would allow one to design a beam line with great speed and reasonable precision. (auth)

30623 HEAVY NEGATIVE ION SOURCE. Martin, J. P.; Levesque, R. J. A. (Univ. of Montreal). Nucl. Instrum. Methods; 80: 229-32(1970). (In French).

A negative ion source, using the principle of direct extraction from the edge of a plasma in a duoplasmatron was constructed and studied. Useful intensities of ^{16}O, ^{19}F, ^{35}Cl, ^{37}Cl, ^{12}C, and ^{32}S were obtained. The compactness and low gas emission allow the source to be placed in the high voltage electrode of an injector for a tandem accelerator. (auth)

30624 POLARIZED BEAM OF THE ERLANGEN-TANDEM ACCELERATOR. Clausnitzer, G.; Duerr, W.; Fleischmann, R.; (and others). (Erlangen-Nuernberg Univ., Erlangen, Ger.). Nucl. Instrum. Methods; 80: 245-63(1970).

The source of polarized protons and deuterons for the Erlangen-EN-tandem accelerator is described. The construction follows the atomic beam method originating in Erlangen about 15 years ago. An accelerated proton beam after a 4 mm × 1.5 mm slit aperture of 1.5 nA with a polarization of 74% is obtained. The corresponding deuteron current is 2 nA with a pure vector polarization of 55%. (auth)

30625 DEFLECTION SYSTEMS FOR STIGMATIC AND ACHROMATIC BEAMS. Aucouturier, J.; Leboutet, H. (Thomson-CSF, Orsay, France). Nucl. Instrum. Methods; 80: 268-76 (1970). (In French).

We seek the necessary conditions for stigmatic and achromatic beam deflection systems. A particular interesting way consists of using magnets which deflect a beam in the same sense of rotation. The properties and characteristics of such systems are established; particular cases, which can be used practically are examined. (auth)

30626 TWO METHODS FOR THE FABRICATION OF SELF-SUPPORTING OSMIUM TARGETS. Casten, R. F.; Greenberg, J. S.; Burginyon, G. A.; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30-1)-3223. Nucl. Instrum. Methods; 80: 296-8 (1970).

Two methods are described for the fabrication of self-supporting isotopically enriched targets of osmium suitable for use in nuclear reaction and scattering experiments. One method leads to thin targets of <1000 $\mu g/cm^2$, the other to targets of many mg/cm^2. A description is provided both of the apparatus and of the procedures developed. (auth)

30627 NEW CONFIGURATION FOR A DIPOLE MAGNET FOR USE IN HIGH ENERGY PHYSICS APPLICATIONS. Meyer, D. I.; Flasck, R. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods; 80: 339-41(1970).

The magnetic field configuration obtained when an ordinary circular solenoid is skewed looks very promising for use as a dipole magnet. The field inside is uniform and $\int Bdl$ including end effect is independent of position across the magnet. (auth)

30628 SOME IMPROVEMENTS OF THE 1.5 GeV ELECTRON SYNCHROTRON OF THE TOMSK POLYTECHNICAL INSTITUTE. Vorobev, A. A.; Visir, V. A.; Ivashin, V. V.; (and others). (Tomsk Polytechnical Inst., USSR). Nucl. Instrum. Methods; 80: 342-4 (1970).

In this paper some improvements are considered for separate units of the accelerator. A feed circuit for the synchrotron electromagnet, able to produce unipolar pulses, was realized and tested. A new rf cavity with a capacitance part of the form of coaxial cylinders was installed into the synchrotron. This eliminated modulation on the envelope of the rf accelerating voltage. A particular case of injection was studied when electrons are kept within the operation space by means of an additional eddy field until the rf voltage in the cavity gap is established. (auth)

30629 TESTING OF A TRITIATED POLYPHENYL TARGET FOR PRODUCING NEUTRONS AT 14 MeV. Peters, J. M.; Guillaume, M.; Del Fiore, G. (Univ., Liege). Nucl. Instrum. Methods; 80: 351-3(1970). (In French).

An organic tritiated target has been prepared from polyphenyl polymer of very high specific activity. The behavior of this target has been tested under a beam of 180 W/cm^2 deuterons. The 14 MeV neutrons yield and half life of the target have been compared with those obtained from a titanium tritiated target. The lack of conductivity of the organic material limits the performance of the organic target. (auth)

30630 INFLUENCE OF CARBON TETRACHLORIDE ON THE BEAM CURRENT IN A SYNCHROCYCLOTRON. Van Genderen, W.; Van Hattem, W. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Instrum. Methods; 80: 293-5 (1970).

The injection of small quantities of carbon tetrachloride directly into the accelerating chamber of a synchrocyclotron, instead of into the ion source, has resulted in an increase of beam current by a factor of three. (auth)

30631 FOCUSING OF PARTICLES IN AN ACCELERATOR WITH STABLE ADJOINING TRAJECTORIES. Lembra, J. (Tartu State Univ.). Izv. Akad. Nauk Est. SSR, Fiz. Mat.; 19: No. 1. 84-6(1970). (In Russian).

The matrix method is used for deriving formulae which permit the calculation of modulus of Floquet's function of betatron oscillations in the accelerator with stable adjoining trajectories of particles. It is shown that the modulus of Floquet's function and, consequently, the amplitude of betatron oscillations, is symmetrical with respect to the middle point, in the straight section of the cavity resonator and in the opposite straight section, only. (auth)

30632 FEW keV ENERGY NEUTRAL ATOMS IN THE BEAM OF A RADIO FREQUENCY ION SOURCE. Bodizs, D. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 28: 145-53(1970).

The ratio of neutral atom "current" to ion current (I^0/I^+) has been investigated in the beam of a r.f. ion source as a function of oscillator power and extraction voltage using hydrogen and helium r.f. discharges. Neutral particles had an energy of few keV according to the extraction voltage. For detecting neutral particles two methods have been employed: a calorimetric method and a method based on secondary electron emission. The I^0/I^+ ratios

were found between 0.75–0.35 in the case of hydrogen and between 0.82–0.57 with helium. A simple method for decreasing the neutral component has also been tested. (auth)

30633 LONG-LIVED RADIOFREQUENCY ION SOURCE OF LOW CONSUMPTION FOR PRESSURIZED ACCELERATORS. Nagy, J. L. (Kossuth Lajos Univ., Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 28: 269-77(1970).

A radiofrequency ion source with extraction electrodes situated outside the discharge tube is reported. A focused ion beam with an intensity of 10 to 200 μA and with a H_1^+ ion content of 57% was obtained using a static transverse magnetic field. The gas consumption was 2.5 cm^3/h and the total electric power was 200 W (including the extraction and focusing) supplied by a small 400 c/sec generator. Excellent stability for many hundred hours and the whole mechanical construction made it possible to use this source in a 1 MeV pressurized Van de Graaff accelerator. (auth)

30634 INVESTIGATION OF VOLTAGE SURGES IN VAN DE GRAAFF GENERATORS. Kiss, A. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 28: 135-43 (1970).

Some results of calculations and model measurements concerning transient voltages occurring in the stack of Van de Graaff generators, subsequent to the sparkovers between the terminal and the earthed tank are presented. The equations giving the transient voltage characteristics and some of their applications are described. The values of capacitances proposed earlier for protection against transients are calculated by a computer for special cases. (auth)

30635 OPTICAL PARAMETERS OF A QUADRUPOLE DOUBLET–ANALYZING MAGNET SYSTEM. Szabo, Gy. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 28: 125-34(1970). (In Russian).

An analysing system consisting of a quadrupole doublet and a deflecting magnet used for electrostatic accelerators is described. The quadrupole doublet matches the beam of cylindrical symmetry outgoing from the acceleration tube to the acceptance of the analysing magnet, and corrects the displacements in position and direction of the beam relative to the optical axis. This arrangement increases the transmission of the analysing magnet significantly. (auth)

30636 NAL: NEW INSTRUMENT FOR PHYSICS RESEARCH. Cole, F. T.; Larsen, Carl W. (National Accelerator Lab., Batavia, Ill.). Nucl. News; 13: No. 4, 38-44(Apr 1970).

A brief historical review of accelerator development which led to the design of the NAL 200-GeV proton synchrotron is given, and the status of the construction is outlined. The general plan of the laboratory, the accelerator system, and the experimental area are described. (W.H.K.)

30637 OAK RIDGE ACCELERATORS. Snell, Arthur H. (Oak Ridge National Lab., Tenn.). Nucl. News; 13: No. 4, 44; 49-51(Apr 1970).

The accelerators at Oak Ridge, Tenn., are mentioned; and recent developments are discussed including APACHE (Accelerator for the Physics and Chemistry of Heavy Elements), ORELA (Oak Ridge Electron Linear Accelerator), and new heavy ion sources. (W.H.K.)

30638 ACTIVITIES AT CERN. Shaw, Edwin N. (CERN, Geneva). Nucl. News; 13: No. 4, 52-8(Apr 1970).

The CERN accelerators and nuclear physics laboratory at Geneva are described, and the 300-GeV project is briefly discussed. Features of the 600-MeV proton synchrocyclotron are discussed, and the parameters of the 28-GeV proton synchrocyclotron are described including the intersecting storage rings (ISR) and other experimental facilities. (W.H.K.)

30639 LOW-ENERGY ACCELERATOR INDUSTRY. Burrill, E. Alfred Nucl. News; 13: No. 4, 58-62(Apr 1970).

A review of the low-energy (below 100 MeV) accelerator industry is presented. Growth in applications, dollar volume, and outlook for the future are discussed. A list of accelerator manufacturers, a table of the distribution of U.S. accelerators by application, and a chart of the distribution in energy of U.S. accelerators (ion and electron) are included. (W.H.K.)

30640 DIFFERENTIAL MATRICES FOR BEAM TRANSPORT SYSTEMS. Reeve, P. A. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods; 81: 207-10(1970).

An attempt is made to systemize the study of the effects of small variations or errors in beam transport elements (e.g. length and field) on the whole system. Essentially this is done by differentiating the transformation matrices and then using these differential matrices in the same way that the transformation matrices themselves are used. In this way the overall differential matrix for the system is found. The technique of using and manipulating the matrices is discussed, and generalized derivations of the differential matrices are given and applications of the technique are summarized. (auth)

30641 SPACE CHARGE EFFECT WITH CROSSING ANGLE. Piwinski, A. (Deutsches Elektronen-Synchrotron, Hamburg). Nucl. Instrum. Methods; 81: 199-200(1970).

Formulas for the shifts of betatron frequencies are derived, which take into account a vertical or horizontal crossing angle, the exact bunch dimensions, and the energy dependence. (auth)

30642 STABILIZED GAS FLOW VALVE FOR ION SOURCE. Bennett, J. R. J.; Walford, H. E. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods; 81: 201(1970).

A precisely controllable, stabilized gas flow valve for the multiply charged heavy ion source of the Harwell Variable Energy Cyclotron is described. (auth)

30643 METHODS OF CRYSTAL ALIGNMENT FOR THE PRODUCTION OF COHERENT BREMSSTRAHLUNG. Luckey, D.; Schwitters, R. F. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Instrum. Methods; 81: 164-72 (1970).

Various methods of precisely aligning crystals in order to make use of the Uberall–Diambrini effect for the production of plane polarized gamma rays are discussed. One method is explained in detail to provide a practical guide for accurately and efficiently aligning the crystal radiators. (auth)

30644 NEW SOURCE OF POLARIZED PROTONS. Boyd, R. N. (Rutgers-The State Univ., New Brunswick, N. J.); Lombardi, J. C.; Robbins, A. B.; Schechter, D. E. Nucl. Instrum. Methods; 81: 149-51(1970).

A source of polarized H^- ions has been built and installed for injection into the Rutgers–Bell tandem Van de Graaff accelerator. This source utilizes a quenching scheme in which the $2S_{\frac{1}{2}}$ ($F = 1$) states are quenched in an rf field at zero static magnetic field. Typically the source produces a 5 nA beam of H^- having a polarization of 50%. (auth)

30645 DESIGN AND ANALYSIS OF A 10 TO 50 MeV MONOENERGETIC POSITRON SOURCE. Bucher, W. P. (National Bureau of Standards, Washington, D. C. Ballistic Research Labs., Aberdeen Proving Ground, Md.). Nucl. Instrum. Methods; 81: 93-103(1970).

Through a matrix description of the capture and acceleration of positrons by a linear accelerator with magnetic guide fields, the optimum design and operating conditions corresponding to the maximum useful yield of positrons are determined. An expression for the differential yield of positrons are determined. An expression for the differential yield is presented which is readily adaptable to various field configurations for the converter lens and to arbitrary radial distributions of positrons at the converter target. (auth)

30646 STUDIES ON CAPTURE EFFICIENCIES OF SYNCHRO-CYCLOTRONS. Kullander, S. (CERN, Geneva). Nucl. Instrum. Methods; 81: 61-71(1970).

It is shown that the capture time in a synchrocyclotron depends critically on the starting phase. The total capture time per acceleration cycle has been derived from an integration over the starting phase interval 0°–60°. The fact that the phase oscillations are damped with increasing energy has been used to minimize the acceleration time. Intensities are estimated by means of the presented results on capture efficiencies and from available space-charge theories. A synchro-cyclotron of 600 MeV energy could be improved to deliver at least 60 μA of protons. (auth)

30647 TARGET CHAMBER FOR RECOIL-DISTANCE LIFETIME MEASUREMENTS. Alexander, T. K.; Bell, A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods; 81: 22-6(1970).

A target chamber for recoil-distance measurements of nuclear lifetimes is described. Measurements indicate that the plunger can be set at 2×10^{-4} inch from a target foil of 0.25 inch diameter without touching. For a recoil velocity of $v/c \approx 3\%$, the time of flight for a distance of 2×10^{-4} inch is $\approx 5 \times 10^{-13}$ s, which is the same order as the slowing down time of ions in metals. A pulse technique has been developed to measure the displacement and zero distance of the plunger from the target foil and is useful for evaluating the mechanical quality of the apparatus. The performance is illustrated by a measurement of the lifetime of the 1369 keV level of ^{24}Mg. The value 2.11 ± 0.16 ps is obtained. (auth)

30648 PREPARATION OF FLAT TARGET FOILS FOR RECOIL-DISTANCE LIFETIME MEASUREMENTS. Gallant, J. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods; 81: 27-8(1970).

A method is developed for the mounting of very flat nickel foils. They are used as backings for targets in recoil-distance measurements of nuclear lifetimes in the range of 10^{-9} to 10^{-12}s. (auth)

30649 MONTE CARLO CALCULATION OF ENERGY DEPOSITION BY THE NUCLEON-MESON CASCADE AND TOTAL-ABSORPTION-NUCLEAR-CASCADE (TANC) COUNTERS. Ranft, J. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods; 81: 29-35(1970).

The energy deposited by the nucleon-meson cascade is calculated using a Monte Carlo method taking into account ionization energy losses of charged particles, nuclear excitation energies, and the energy deposited by electromagnetic showers initiated by decaying π^0 mesons. The calculation is applied to TANC-counters, and the performance of these counters is calculated for incoming protons with momenta between 8 and 100 GeV/c. The Monte Carlo results for 8 GeV/c protons agree qualitatively with experimental results for 8 GeV/c pions. (auth)

30650 NEW HIGH INTENSITY ION SOURCE WITH VERY LOW EXTRACTION VOLTAGE. Geller, R. (CEA, Saclay, France). Appl. Phys. Lett.; 16: 401-4(15 May 1970).

A new ion source that produces slow ion beams of $I^+ > 10^{-2}$ A cm^{-2} with extraction voltages $V_{extr} \gtrsim 10^2$ V and a relatively small spread is described. (auth)

30651 ACCELERATOR ENERGY CALIBRATION UTILIZING THE ^{58}Ni(p,n) REACTION. Raman, S.; Kim, H. J.; Wells, G. F. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 81: 331-3(1970).

The γ-spectra from ^{58}Cu and the neutron spectra from the ^{58}Ni(p,n) ^{58}Cu reaction have been utilized to check the energy calibration of the analyzing magnet. (auth)

30652 A FACILITY FOR MEASUREMENT OF PHOTOALPHA ANGULAR DISTRIBUTIONS. Keller, N. A.; McConnell, D. B. (Univ. of Toronto). Nucl. Instrum. Methods; 81: 305-9(1970).

A facility for the measurement of photoalpha angular distributions has been developed using solid state detectors. Preliminary results for photoalphas from zinc and silver are presented. The main advantages of the system are rapid simultaneous data acquisition with acceptable background levels at three angles, 45°, 90°, and 135°. (auth)

30653 DOOR ALARM AND INTERLOCK SYSTEM AT THE LOS ALAMOS TANDEM ACCELERATOR FACILITY. Seitz, T. P.; Lang, H. J.; Henkel, R. L. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 81: 291-5(1970).

Like most accelerator facilities, the Los Alamos tandem accelerator facility was designed to provide adequate radiation shielding to personnel. To permit maximum use of the facility during accelerator operation, a door alarm and interlock system was designed to control access to areas of possible radiation. The system provides a programmed method of selecting various control conditions for entrances to radiation areas, depending upon the amount of radiation in the area and the amount of control desired. This enables personnel to work safely in given areas while experiments are in progress in other areas. (auth)

30654 INVESTIGATION OF PHASE DENSITY REDISTRIBUTION PROCESSES IN INTENSE PROTON BEAMS, EXTRACTED FROM ION SOURCES OF DUOPLASMATRON TYPE. Kusnetsov, V. S.; Abroyan, M. A.; Fidelskaya, R. P. (Scientific Research Inst. of Electrophysical Apparature, Leningrad). Nucl. Instrum. Methods; 81: 296-300(1970).

The results of measurements of phase density distribution in intensive proton beams, extracted from an ion source of duoplasmatron type, are given and analyzed. It is found that the distribution f in real beams differs considerably from the microcanonical one. By numerical solution of the equation system describing beams with an arbitrary distribution f, it is shown that in investigated beams, phase density redistribution takes place, and because of this, considerable distortion of current density and phase volume configuration occurs. (auth)

30655 OBTAINING THE PRE-RELATIVISTIC ELECTRON BUNCHES OF VERY SHORT DURATION FOR INJECTION IN A LOW-ENERGY LINEAR ACCELERATOR. Marcou, J.; Papiernik, A.; Wartski, L. (CNRS, Orsay, France). Nucl. Instrum. Methods; 81: 239-42(1970). (In French).

Adjustable numbers of very short electron bunches, injected in a low energy accelerator model have been obtained by using a traveling-wave folded deflecting line. (auth)

30656 LOW-TEMPERATURE ELECTRON IRRADIATION FACILITY. Hemmerich, J.; Sassin, W.; Schilling, W. (Kernforschungsanlage, Juelich, Ger.). Z. Angew. Phys.; 29: 1-6 (23 Apr 1970). (In German).

A facility for irradiating samples at 4.5°K with a high electron flux density was constructed. A highly efficient beam-guide system consisting of solenoid quadrupole lenses and deflection systems in connection with some changes on the electron source of the 3-MeV van de Graaff accelerator provides an electron beam spot of variable size with a homogeneous current density distribution. Beam-current densities of 100 μA /cm^2 covering a sample area of 2 cm^2 with a homogeneity better than 10% are possible. The cooling of the samples is performed by direct heat transfer to liquid helium, which is provided by a He refrigerator with a cooling capacity of 160 W at a temperature of 4.5°K. (auth)

30657 ACCELERATION OF HEAVY IONS. Livingston, Robert S. (Oak Ridge National Lab., Tenn.). Particle Accel.; 1: 51-77(Apr 1970).

The history and present status of the acceleration of heavy ions is reviewed. Some of the factors influencing the choice of accelerating systems for heavy ions are analyzed. A comparison of relative ion source performance is given, as is a discussion of the stripping estimates of the most recent Nikolaev average ion charge interpolation formula. Some considerations of the many new ideas for heavy ion acceleration are included. (70 references). (auth)

30658 HEAVY IONS AND HIGHER PROTON CURRENTS PROPOSED FOR THE PRINCETON–PENNSYLVANIA ACCELERATOR. Isaila, M.; Kirchgessner, J.; Prelec, K.; Shoemaker, F. C.; White, M. G. (Princeton Univ., N. J.). Particle Accel.; 1: 79-92(Apr 1970).

The Princeton–Pennsylvania Accelerator (PPA), because of its original design specifications, is uniquely suited for use as a heavy ion accelerator. With the improvement of the vacuum system and other relatively minor modifications, very heavy nuclei could be accelerated to an energy of 6–8 MeV per nucleon and with currents sufficient for the search for the stable, superheavy transuranic elements predicted by theory. The addition of a small booster synchrotron (PPB) to inject protons at 75 MeV would raise proton currents by a factor of twenty to 10^{12} per pulse or 2×10^{13} per second. The same booster would make possible the acceleration of fully stripped ions to very high energies by two successive acceleration steps in the PPA. The PPA coupled with the presently designed booster could produce krypton with 900 MeV per nucleon or 76 BeV total. In principle the PPA could accelerate uranium to 191 BeV. At such high energies one may expect some coherent production of particles whose thresholds lie above the free nucleon–nucleon collision energies. Also one would expect the formation of shock waves in nuclear matter. (auth)

30659 THE OPERATION OF THE FIRST SECTION OF THE NAL LINEAR ACCELERATOR. Curtis, C. D.; Goodwin, R. W.; Gray, E. R.; Livdahl, P. V.; Owen, C. W.; Shea, M. F.; Young, D. E. (National Accelerator Lab., Batavia, Ill.). Particle Accel.; 1: 93-109(Apr 1970).

The initial performance of the 10-MeV section of the NAL 200-MeV linear accelerator is presented. The preaccelerator, mechanical and rf systems of the linac, beam transport lines, diagnostic equipment and computer control system are described briefly. Beam emittance, profiles, momentum spread and operating linac parameters processed through the computer are displayed. The maximum beam current accelerated to 10.4 MeV was 160 mA with a cavity transmission of 72%. The phase-space density was significantly higher in the core of the beam than near the periphery. For a 150-mA beam the measured emittance areas including 80% of the beam current were 10 and 15 milliradian-cm in the x and y planes respectively. The beam-emittance growth through the linac was measured and a graph showing variations occurring under different operating conditions is presented. The total momentum spread of the 10-MeV beam, independent of beam current, was 1.0% for approximately 90% of the beam. Further improvements in beam quality can be expected from optimization of linac parameters. (auth)

30660 COHERENT INSTABILITIES IN HIGH CURRENT LINEAR INDUCTION ACCELERATORS. Neil, V. Kelvin; Cooper, Richard K. (Univ. of California, Livermore). Particle Accel.; 1: 111-20(Apr 1970).

Unstable coherent motion of the beam in a high current ($I \simeq$ 1000 A) linear induction accelerator has been observed. The instability has been attributed to resonances with various structures in the beam's path. The effect of resonances with the accelerating units on both transverse and longitudinal coherent oscillations of the beam is investigated theoretically. The theory of Panofsky and Bander is extended and generalized to include both types of motion.

The stabilizing mechanism of a spread in particle velocity and/or transverse oscillation frequency are included in the treatment of the transverse motion. Stability criteria are derived that place lower limits on these spreads. These criteria depend upon the quality factor, Q, of the structures, and it is shown that both a spread and a finite Q are necessary for stability. (auth)

30661 THE PRINCIPLE OF SELF-COLLIDING ORBITS AND ITS POSSIBLE APPLICATION TO $\pi-\pi$ AND $\mu-\mu$ COLLISIONS. Macek, Robert (Los Alamos Scientific Lab., N. Mex.); Maglic, Bogdan. Contract AT(30-1)-2171. Particle Accel.; 1: 121-36 (Apr 1970).

A principle for storage and collision of particles that are not available as targets is proposed; it provides interactions over the entire orbits of particles emitted with all crossing angles and momenta. The self-colliding orbits are achieved in a containing magnetic field in which the orbits precess about the center of symmetry which can also be the center of the production target. In the peripheral zone of the field, the momenta of positive and negative particles are antiparallel, thereby implying head-on collisions. All particles, regardless of their production angles, are eventually brought into this colliding zone by the virtue of their precession. This device, referred to as the "Precetron," has a large momentum acceptance of pions, $\Delta p/p = 50\%$, and large angular acceptance, ±180° in the horizontal and ±10° in the vertical plane, in contrast to a conventional storage ring concept which would require well-defined momentum and small angular divergence. Single particle orbits have been calculated to first order; the precessing character of the orbits and the stability of the free oscillations are shown. Formulae for particle densities and luminosity in the colliding region have been derived for unstable particles. A Precetron with off-center target is also considered. (auth)

30662 DESIGN AND FABRICATION OF THE SEPTUM COIL OF THE BEVATRON EXTRACTION MAGNET M1 MARK 4. Lake, Addison A. (California Univ., Berkeley). Particle Accel.; 1: 137-41(Apr 1970).

This report covers the design and fabrication of a narrow septum magnet installed in the LRL Bevatron external proton beam resonant extraction system. It describes the sizing of the copper conductor, the testing of insulating materials, and the choice of metallized ceramic as the structural insulator. Magnetic-field-induced stresses in the septum are calculated for the conductor and insulator. The report also reviews alternative designs and the reasons for their rejection. Fabrication of rectangular conductor from round tubing is described. The procedure is given for the joining by vacuum brazing of the conductors and insulators. Coil operating data are listed. (auth)

30663 INTRODUCTION TO A LINEAR THEORY OF ACCELERATORS. NOTE I. STUDY OF THE VERTICAL OSCILLATIONS AND CALCULATION OF THE DAMPING COEFFICIENTS IN THE CASE OF WEAK-FOCUSING. Uccelli, Fabio (Univ., Pisa, Italy). Ric. Sci.; 39: 305-14(Apr-Jun 1969).

The linear theory (in the Gauss approximation) of relativistic motion of particles inside a circular accelerator is presented according to a unified method. The vertical motion of particles is studied, and damping coefficients in the case of weak-focusing are calculated. (W.H.K.)

30664 INTRODUCTION TO A LINEAR THEORY OF ACCELERATORS. NOTE II. STUDY OF THE HORIZONTAL OSCILLATIONS AND CALCULATION OF THE DAMPING COEFFICIENTS IN THE CASE OF WEAK-FOCUSING. Uccelli, Fabio (Univ., Pisa, Italy). Ric. Sci.; 39: 315-17(Apr-Jun 1969).

The methods used in "Introduction to a Linear Theory of Accelerators. Note I" are used to study the horizontal motion of particles in circular accelerators (W.H.K.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 29564, 30375, 30610, 30629, and 30893.

30665 (BNWL–1262) NEUTRON SPECTRA OF PLUTONIUM COMPOUNDS. PART 1. ^{3}He AND ^{6}Li SPECTROMETER MEASUREMENTS. Brackenbush, L. W.; Faust, L. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1970. Contract AT(45-1)-1830. 34p. Dep. CFSTI.

The neutron energy spectra of compounds of high-exposure plutonium (23 percent ^{240}Pu) are presented. The neutron spectrum of plutonium tetrafluoride shows a peak at 1.3 MeV, which agrees with previously published measurements; the neutron spectrum of plutonium dioxide is shown to have a very broad peak at about 2 MeV. A previously unreported spectrum of a plutonium-aluminum alloy (21 percent Pu–79 percent Al) is presented with a peak at about 1.6 MeV. The average fluence to dose conversion factors calculated from the measured spectra are: plutonium dioxide–2.7×10^{-9} rad/n/cm^2, plutonium tetrafluoride–2.5×10^{-9} rad/n/cm^2, plutonium-aluminum alloy–2.6×10^{-9} rad/n/cm^2, and plutonium metal (spontaneous fission spectrum)–2.6×10^{-9} rad/n/cm^2. (auth)

30666 (DP–1224) DIFFUSIVE SLOW NEUTRON SCATTERING LAW. Clifford, L. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan 1970. Contract AT-(07-2)-1. 31p. Dep. CFSTI.

The diffusive center of mass motion of particles is derived by assuming that the particles are coupled to a heat bath by a dipole interaction. Both the particles and the bath are treated as quantum mechanical systems. The equations of motion are obtained by using a perturbation method which describes dissipative effects in quantum mechanics. The diffusive slow neutron scattering law for the center of mass motion of particles in a liquid is then derived in the incoherent approximation. The scattering law satisfies the principle of detailed balance and the zeroth and first energy transfer moment theorems. The scattering law is expressed as a series of incomplete gamma functions and is evaluated in that form. (auth)

30667 (IN–1304) VERY INTENSE NEUTRON SOURCE (VINS). Brugger, R. M.; Russell, G. J.; Johnson, B. W.; DeVault, G. P. (Idaho Nuclear Corp., Idaho Falls). Apr 1970. Contract AT(10-1)-1230. 53p. Dep. CFSTI.

The conceptual design of a neutron source is described. This device, called Very Intense Neutron Source (VINS) would produce bursts of neutrons to be used for fast and thermal neutron beam experiments by time-of-flight methods. The source would have an effective source flux for beam experiments several orders of magnitude above those fluxes now available at the best neutron sources. In the concept the neutrons produced by an electron linear accelerator would be multiplied by fast reactor modules. These modules would be arranged to provide maximum multiplication while limiting the shock and heat and limiting multiplication of those neutrons from the delayed neutron precursors. The experimental arrangement and uses of VINS are stressed. (auth)

30668 (RT/FI–(69)3) USE OF NEUTRON FILTERS IN THE INVESTIGATION OF RESONANCE CAPTURE OR RESONANCE FISSION EVENTS IN THE THERMAL ENERGY RANGE. Pistella, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 2 Jan 1969. 46p. Dep. CFSTI (U. S. Sales Only).

The behavior of Gd as a neutron filter is investigated for the 1/v, the Eu-151 and the Pu-239 detectors, for different filter thicknesses and in different neutron spectra. A double filter technique is suggested using Gd filters and Cd filters with the aim of investigating the thermal spectrum in presence of resonance absorbers (like Pu-239) as well as of examining the dependence of the fission yields on the energy spectrum of neutrons producing the fission events. (auth)

30669 (RT/FI–(70)3) TRANSPORT COEFFICIENTS OF THERMAL NEUTRONS IN A PROTON FREE GAS. Molinari, V. G.; Rossi, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 27 Nov 1969. 18p. Dep. CFSTI (U. S. Sales Only).

The transport coefficients of thermal neutrons, that enter the expressions of the current density and the energy flow when a gradient of neutron density and of temperature occurs, are calculated in the framework of the proton free gas model when the isotropic part of the neutron velocity distribution is supposed to be a Maxwellian at some temperature, function of x, different from the moderator temperature. These coefficients satisfy the Onsager relations. (auth)

30670 ULTRACOLD NEUTRONS. Okun, L. B. Comments Nucl. Particle Phys.; 3: 133-5(Sep-Oct 1969).

An experiment dealing with ultracold neutrons, which may be stored in a closed vessel, like ordinary gases, until they decay, is discussed. The experiment consisted of counting the ultracold neutrons from the pulsed reactor IBR and determining the neutron diffusion time from the moderator to the detector. The new possibilities presented by the use of ultracold neutrons, on which an electric field can be applied for 10^3 seconds, in the search for the electric dipole moment of the neutron are discussed. (L.W.A.)

30671 EXPERIMENTAL MEASUREMENT OF THE HIGH ENERGY GAMMA RAYS PRODUCED BY THE SLOWING DOWN OF 14 MeV NEUTRONS IN AIR. Thorngate, John H. (Oak Ridge National Lab., Tenn.). Health Phys.; 18: 339-45(Apr 1970).

During Operation HENRE (High Energy Neutron Reactions Experiment), measurements were made of the gamma-rays produced in air by 14 MeV neutrons. Spectra were obtained for the gamma-rays in the energy interval of 1.5 to 10 MeV at slant ranges of 482 and 571 m. At the greater range, spectra were recorded at angles of 0°, 45°, and 90° with respect to the source-detector line using a collimator that had a conical opening with a 30° total angle. The techniques needed for adequate data reduction are discussed. Agreement with calculated spectra is reasonable, but the measurements have more gamma-rays in the 3 to 5 MeV region. The difference is thought to be due primarily to insufficient cross section data for the calculations. (auth) (UK)

30672 COMPACT NEUTRON GENERATOR TUBE STRUCTURE. Frentrop, Arthur H. (to Schlumberger Tech. Corp.). U. S. Patent 3,508,058. 21 Apr 1970. Filed 31 Mar 1967.

One embodiment of the invention describes a neutron generator tube in which the gas supply is thermally isolated from the ion source by reflective and conductive heat members. The conductive heat member is in thermal contact with the tube envelope to permit the envelope to dissipate waste heat from the ion source to an insulating gas (SF_6) in a well logging tool housing. The tool housing also is insulated from an ion source magnet to prevent arcing between the magnet and the tube envelope. (auth)

30673 SMALL ANGLE MAGNETIC ne-SCATTERING. Baryshevskii, V. G.; Korennaya, L. N. Zh. Eksp. Teor. Fiz.; 58: 1086-9(Mar 1970). (In Russian).

Inelastic magnetic scattering of neutrons by electrons is considered. It is shown that for small angles and transfers, deviations from the usual behavior of the scattered wave appear. As a consequence, the relation between the scattering differential cross section and magnetic susceptibility tensor of the substance appreciably changes. (auth)

30674 MONTE CARLO TECHNIQUE FOR CORRECTING EXPERIMENTAL FAST-NEUTRON POLARIZATION DATA. Miller, T. G. (Army Missile Command, Redstone Arsenal, Ala.); Gibson, F. P.; Morrison, G. W. Nucl. Instrum. Methods; 80: 325-32(1970).

A Monte Carlo code has been written to correct experimental fast neutron polarization data for finite geometry and multiple scattering effects, when liquid helium is the polarizer analyzer. The code uses phase shifts to calculate the necessary parameters, the angular distribution $d\sigma/d\Omega$, the polarization P and the spin rotation parameter β needed for consistent tracking of polarization effects in successive scatterings. The code adjusts the initial input polarization needed to reproduce the measured left-right ratio. (auth)

30675 $^{9}Be(\alpha,n)^{12}C$ AS A SOURCE OF POLARIZED 7.8 MeV NEUTRONS. Stammbach, Th.; Spalek, G.; Taylor, J.; Walter, R. L. (Triangle Universities Nuclear Lab., Durham, N. C. Duke Univ., Durham, N. C.). Nucl. Instrum. Methods; 80: 304-8(1970).

The polarization $P(\theta)$ of the neutrons produced in the $^{9}Be(\alpha,n)$ ^{12}C reaction to the ground state and first excited state of ^{12}C have been measured for α energies for 2.4 to 2.9 MeV over the angular range from 30° (lab) to 60° (lab). A ^{9}Be target with 100 keV energy loss was used in the study. Also, a highly accurate determination of P(45°) was made with a 300 keV thick target at a mean α energy of 2.55 MeV to calibrate the reaction as a source of polarized neutrons. This measurement yielded polarizations of 0.54 ± 0.01 for the ground state group (7.8 MeV) and 0.53 ± 0.03 for the first excited state group (3.38 MeV). (auth)

30676 ROTATIONAL CORRELATION FUNCTIONS AND NEUTRON SCATTERING BY SYMMETRIC MOLECULES. Argawal, Ashok K. (Argonne National Lab., Ill.); Yip, Sidney. Phys. Rev., A; 1: 970-4(Mar 1970).

Classical rotational correlation functions for symmetric molecules are derived from quantum-mechanical results in neutron scattering. The analysis differs from an earlier calculation in that all values of the projection quantum number are considered. The results agree with those obtained by St. Pierre and Steele using classical statistical mechanics. Numerical results for ammonia and water are presented. (auth)

30677 SLOW-NEUTRON SCATTERING BY SOLID ORTHO-HYDROGEN BELOW THE λ TEMPERATURE. Misenta, R.; Olivi, L. (EURATOM-CCR, Ispra, Italy). Solid State Commun.; 8: 373-5(15 Mar 1970).

The elastic and inelastic differential cross sections for the scattering of slow neutrons by ortho-H_2 molecules with the directional quantum numbers m = 0 and m = ±1 were derived. It is proposed to measure the temperature dependence of these cross sections in a single crystal of normal H_2 in order to obtain information on possible structures of solid ortho-hydrogen. (auth) (UK)

30678 NEUTRON TRANSPORT IN A NONUNIFORM SLAB WITH GENERALIZED BOUNDARY CONDITIONS. Belleni-Morante, A. (Univ. of Illinois, Urbana). J. Math. Phys. (N. Y.); 11: 1553-8(May 1970).

The existence and the uniqueness of the solution of the initial-value problem for neutron transport in a nonuniform slab with generalized boundary conditions, which include the vacuum and the perfect reflection boundary conditions as particular cases is proved. Moreover, it is shown that the position-dependent transport operator has at least one real eigenvalue and the asymptotic behavior of the neutron density as $t \to +\infty$ is indicated. (auth)

30679 CALIBRATION OF Am-alpha-Be NEUTRON SOURCE BY THE MANGANESE SULFATE METHOD. Rada, G.; Ollarves, H. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Acta Cient. Venez.; 20: No. 1-2, 26-7(1969). (In Spanish).

The calibration of an Am-α-Be neutron source by using the manganese sulfate bath is described. Westcott's effective cross-sections have been used for the manganese and sulfur in the solution, to correct for epithermal absorption and deviations from 1/v law. (auth)

30680 INTENSE NEUTRON GENERATOR. Fraser, John S. (to Atomic Energy of Canada Ltd., Ottawa). U. S. Patent 3,500,098. 10 Mar 1970. Filed 22 Oct 1965.

An intense neutron generator including a beam tube with an end opening into a target area of liquid metal is described. A stream of protons is directed against the liquid metal causing a nuclear cascade and producing a high neutron flux. The liquid metal flows past the open end of the beam tube to create a cavitation bubble and form a windowless vacuum seal. The liquid metal is also circulated through a heat exchanger to reject heat generated during proton bombardment. The preferred liquid metal is a lead bismuth alloy and the most preferred is the eutectic. (Official Gazette)

30681 APPLICATIONS OF THE METHOD OF MATCHED ASYMPTOTIC EXPANSIONS TO A PROBLEM IN LINEAR TRANSPORT THEORY. Hendry, W. L. (Los Alamos Scientific Lab., N. Mex.). J. Math. Phys. (N. Y.); 11: 1743-9(May 1970).

The method of matched asymptotic expansions is used to reduce the time-dependent, one-velocity neutron transport equation to a set of more tractable equations. This reduction is accomplished subject to general initial conditions on both the neutron flux and delayed neutron precursors. (auth)

30682 ORTHOGONALITY OF A SET OF POLYNOMIALS ENCOUNTERED IN NEUTRON-TRANSPORT AND RADIATIVE-TRANSFER THEORIES. Inoenue, Erdal (Univ. of Miami, Coral Gables, Fla.). J. Math. Phys. (N. Y.); 11: 568-77(Feb 1970).

The properties of the polynomials $n_l(\nu)$ which appear in the spherical-harmonics expansion of the eigen-solution $\phi_\nu(\mu) = \Sigma_{l=0}^{\infty} \frac{1}{2}(2l+1)P_l(\mu)h_l(\nu)$ in plane-symmetric one-speed transport problems with anisotropic scattering are reviewed and further investigated. These polynomials are shown to be orthogonal in the Stieltjes sense with a weight distribution which contains a continuous as well as a discrete portion. Some further properties of the $h_l(\nu)$ are listed, taken from the Tchebycheff theory of orthogonal polynomials. (auth)

30683 ONE-SPEED TRANSPORT DISADVANTAGE FACTOR CALCULATIONS FOR GENERAL ANISOTROPIC SCATTERING. Eccleston, G. W., Jr.; McCormick, N. J. (Univ. of Washington, Seattle). J. Nucl. Energy; 24: 23-34(Feb 1970).

The singular eigenfunction expansion method was used to obtain the solution for the one-speed disadvantage factor in slab cells of fuel and moderator which may scatter neutrons in a highly anisotropic manner. New two-media cross-product integral relations, together with previously known one-medium orthogonality relations, were utilized to obtain the solution. Sample calculations on slab cells of natural uranium and water show that, for cases in which the anisotropy of the scattering is quadratic or more, the disadvantage factor differs from the isotropic result by 7–27% depending upon the order of the anisotropy, the effective mass of the scatterer, and the slab cell width. In all calculations, scattering in the fuel was assumed to be isotropic. (auth) (Canada)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 30431, 30443, and 30956.

30684 (BNL-14468) EPITHERMAL NEUTRON CAPTURE γ RAYS. Chrien, R. E. (Brookhaven National Lab., Upton, N. Y.). [1970]. 29p. (CONF-700204-1). Dep. CFSTI.

From IAEA Meeting on Research Reaction Utilization, Rome, Italy.

The use of epithermal capture as a spectroscopic tool is discussed and its advantages are presented. Examples of the two kinds of epithermal experiments—diffraction methods, which can be used to follow the transition probability as a detailed function of neutron energy, and filtered beam methods, which can be used to obtain broad energy averages over the initial states in an effort to obtain a more equal population of final states than is achieved in thermal capture—are discussed. (L.W.A.)

30685 ANALYTICAL SENSITIVITIES AND ENERGIES OF THERMAL-NEUTRON-CAPTURE GAMMA RAYS. Duffey, D.; El-Kady, A. (Univ. of Maryland, College Park). Nucl. Instrum. Methods; 80: 149-71(1970).

A table of the analytical sensitivities of the principal lines in the thermal-neutron-capture gamma ray spectrum has been compiled for most of the elements. In addition a second table of the full-energy, single-escape, and double-escape peaks has been compiled according to energy for all significant lines above 3 MeV. Lines that contrast well with adjacent lines are noted as prominent. The tables are useful for spectral interpretation and calibration. (auth)

30686 STUDY OF THE d + d SYSTEM USING THE METHOD OF RESONATING-GROUP STRUCTURE. Thompson, D. R. (California Inst. of Tech., Pasadena). Nucl. Phys.; A143: 304-14(1970).

The method of resonating-group structure with a one-channel approximation is used to study the d + d and d^* + d^* systems. The calculated ^{2}H(d, d)^{2}H differential cross sections agree fairly well with those determined experimentally. Also, evidence is found for an l = 1 state near the d + d threshold and possibly, a D-wave resonance near 30 MeV excitation in ^{4}He. Further, no indication of the existence of a bound ^{4}n system is obtained. (auth)

30687 CAPTURE RATE FOR THE REACTION ^{3}He + $\mu^- \to {}^3$H + ν. Guancial, E.; Lin, D. L. (State Univ. of New York, Buffalo). Nuovo Cim.; 67A: 538-52(1 Jun 1970).

The capture rate for the process ^{3}He + $\mu^- \to {}^3$H + ν is calculated following the usual approach involving an effective Hamiltonian. The trinucleon wave function used is a solution to the three-body wave equation with separable two-body potentials including the tensor forces. It is a linear combination of the ^{2}S symmetric states, the mixed-symmetry ^{2}S state and the three mixed-symmetry ^{4}D states. The calculated capture rate agrees in general with existing work. The ratio of the induced pseudoscalar and axial vector coupling constants, $m_\mu F_P/F_A$, that is deduced from this calculation is somewhat smaller than that predicted by the Goldberger-Treiman relation. It is pointed out that since the contribution of the D-state apparently decreases the capture rate and consequently the pseudoscalar coupling constant, it is reasonable to expect that a wave function with a smaller D-state admixture will yield results consistent with both the radiative-muon-capture results and the Goldberger-Treiman prediction. A preliminary calculation and brief discussion of this possibility is also given. (auth)

30688 INTERACTION OF 42 MeV α-PARTICLES WITH ^{3}He. Vincent, John S.; Boschitz, Edmund T. (Lewis Research Center, Cleveland). Nucl. Phys.; A143: 121-9(1970).

The differential cross section for elastic scattering of 42 MeV α-particles from ^{3}He is measured between 20° and 160° c.m. A

phenomenological description of the elastic scattering data is given by an optical-model calculation. To reproduce the shape of the differential cross section, the absorptive potential is required to extend radially beyond the real potential. Including a small spin-orbit potential in the calculation improves the agreement with the experiment and predicts a polarization which is consistent with one measurement at a nearby energy. The reaction cross section given by the optical-model calculation is close to a lower limit estimated from integration of inelastic events observed. The two-body reactions $^3He(\alpha,p)^6Li$ ground and first excited state, measured between 20° and 160° c.m., are discussed. Optical potentials determined from elastic scattering data are used in a distorted wave Born approximation prediction for these cross sections. Qualitative agreement is obtained assuming only the ^3He stripping mode. (auth)

30689 ELASTIC SCATTERING OF 580-MeV PROTONS FROM ^3He. Blecher, M. (Virginia Polytechnic Inst., Blacksburg); Gotow, K.; Boschitz, E. T.; Roberts, W. K.; Vincent, J. S.; Gugelot, P. C.; Perdrisat, C. F. Phys. Rev. Lett.; 24: 1126-8(18 May 1970).

The elastic differential cross section for $p-{}^3He$ scattering has been measured at 580 MeV. The data are compared with a Glauber model calculation. (auth)

30690 POLARIZATION IN $^3He+{}^4He$ ELASTIC SCATTERING. Hardy, D. M. (Rice Univ., Houston, Tex.); Spiger, R. J.; Baker, S. D.; Chen, Y. S.; Tombrello, T. A. Phys. Lett.; 31B: 355-7(16 Mar 1970).

Results of ^4He elastic scattering from a polarized ^3He target complement recent ^3He double scattering data and provide information for the design of efficient ^3He polarimeters. (auth)

30691 NEUTRON–DEUTERON SCATTERING WITH SOFT-CORE. Cahill, R. T.; Sloan, I. H. (Univ. of New South Wales, Kensington). Phys. Lett.; 31B: 353-4(16 Mar 1970).

Elastic neutron-deuteron scattering below 15 MeV was calculated using the Tabakin rank-one separable interaction, which includes short range repulsion, for the ^1S state, and the Yamaguchi central separable interaction for the ^3S state. The results are compared with the S-wave phase shifts of van Oers and Seagrave obtained by phase shift analysis. (auth)

30692 ON RESONANCE OF REACTION $D(d,p)^3He$ AT LOW ENERGIES. Ad'yasevich, B. P.; Antonenko, V. G.; Fomenko, D. E. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 11: 732-5(Apr 1970). (In Russian).

The vector $P_y^a(90°)$ and tensor $P_{33}^a(90°)$, and $P_{11}^a(90°)-P_{22}^a(90°)$ analyzing powers of the reactions $D(d,p)^3H$ in the energy region 60 to 150 keV as well as the left-right asymmetry $\epsilon(90°)$ of this reaction in the region 60–505 keV were measured by a polarized deuteron beam. The values measured have no noticeable resonance singularities previously observed particularly near 105 keV. (auth)

30693 COINCIDENCE STUDIES OF THE REACTIONS $^3He+{}^3H$ AND $^4He+{}^2H$. Assimakopoulos, P. A. (Rutgers–The State Univ., New Brunswick, N. J.).; Beardsworth, E.; Boyd, D. P.; Donovan, P. F. Nucl. Phys.; A144: 272-88(1970).

The reactions $^2H(^4He,^4He\ p)n$, $^2H(^3He,^3He\ p)n$ and $^2H(^3He,^3H\ p)p$ were studied at incident helium energies of 18.0 and 24.0 MeV. In the $^2H(^4He,^4He\ p)n$ reaction the ^4He and p were detected in coincidence at angles which allow low relative momentum of the proton and neutron in the final state. The singlet p-n final state interaction (FSI) was not observed (limit <3% of the triplet FSI), in agreement with the prediction of isospin conservation. In the $^2H(^3He,^3He\ p)n$ reaction the singlet p-n FSI was observed. Analysis of these data for the extraction of the p-n scattering length was performed. In the same reaction, a measurement at quasi-free (neutron spectator) angles showed that the spectator-pole cross-section peak was shifted in energy from the value predicted by the simple knock-out model. This effect was reproduced by adding to the knock-out calculation "Coulomb pushing" between the incident helium nucleus and deuteron. The first and second excited states of ^4He were observed at excitation energies (E*) and widths (Γ) of $E^* = 20.01 \pm 0.02$ MeV, $\Gamma = 0.12 \pm 0.02$ MeV and $E^* = 21.36 \pm 0.10$ MeV, $\Gamma = 2.0 \pm 0.2$ MeV, respectively. Contributions probably due to higher ^4He states were seen in the data. Angular correlation results were compatible with a spin zero assignment to the first excited state of ^4He. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 29547, 29560, 30445, 30675, 30684, 30685, 30741, 30875, 30879, 30881, and 30925.

30694 INTERACTION OF HIGH ENERGY α PARTICLES WITH NUCLEI. Vikhrov, A. I.; Dudkin, V. E.; P'yanov, I. I.; Sysoeva, O. V. Yadern. Fiz.; 11: 36-42(1970). (In Russian).

Interaction of α particles with energy of few hundred MeV with the ^{14}N, ^{27}Al, ^{93}Nb, and ^{108}Ag nuclei was calculated using the Monte Carlo method on the basis of the cascade-evaporation model. Comparison of the calculated results with the experimental data available shows that the model used allows one to describe reasonably enough general characteristics of the interaction. (auth)

30695 γ RAYS AT INELASTIC INTERACTIONS OF 14-MeV NEUTRONS WITH NUCLEI OF N, O, Al, Fe. Sukhanov, B. I.; Tkach, N. P. Yadern. Fiz.; 11: 33-5(1970). (In Russian).

Cross sections are presented of the γ-quanta yields resulting from inelastic interactions of the 14-MeV neutrons with the nuclei of N, O, Al, and Fe. The measurements were made in the energy region $E_\gamma = 0.7$ to 4.5 MeV by means of a two-crystal Compton γ spectrometer. (auth)

30696 INELASTIC SCATTERING OF 104-MeV α-PARTICLES ON ^{12}C, ^{20}Ne, AND ^{64}Ni. Specht, J. (Kernforschungszentrum, Karlsruhe, Ger.); Rebel, H.; Schatz, G.; Schweimer, G. W.; Hauser, G.; Loehken, R. Nucl. Phys.; A143: 373-84(1970).

The differential cross sections for the inelastic scattering of 104-MeV α particles on ^{12}C, ^{20}Ne, and ^{64}Ni were measured. The experimental data are successfully described in the frame of the Austern–Blair theory including higher-order excitations. Multiple excitations prove to be important. For ^{20}Ne and ^{64}Ni the extracted spectroscopic quantities are discussed in terms of the collective model. In the case of ^{20}Ne a hexadecapole deformation becomes evident. (auth)

30697 ON THE (p,α) DIRECT-REACTION MECHANISM IN LIGHT NUCLEI. Guazzoni, P.; Iori, I.; Micheletti, S.; Molho, N.; Pignanelli, M.; Tagliaferri, G. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cim.; 67A: 407-16(1 June 1970).

Differential cross-sections for (p,α) reactions have been obtained at $E_p = 26.7$ MeV for ^9Be, ^{11}B, ^{19}F and at several proton energies between 25 and 45 MeV for ^{12}C and ^{16}O. For these two nuclei a marked variation with proton energy of both the shape of the angular distribution and the integrated cross-section is found. The present results, and the earlier ones at $E_p = 38$ MeV, have been compared with PWBA calculations for the four direct mechanisms (pick-up, knock-out, heavy-particle pick-up and heavy-particle knock-out) taking into account their interference terms. (auth)

30698 SPECTRA AND YIELDS OF FAST CHARGED PARTICLES AT ABSORPTION OF π^- MESONS AT REST BY CARBON NUCLEI. Vaisenberg, A. O.; Rabin, N. V.; Kuzichev, V. F. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 48-53(1970). (In Russian).

Yields and energy distributions of fast protons and deuterons emitted at absorption of negative pions by carbon nuclei are investigated. It is shown that the number of secondary particles with energies more than 50 MeV per a capture event is $(12.5 \pm 3.5)\cdot 10^{-3}$ and $(4.2 \pm 1.2)\cdot 10^{-3}$ for protons and deuterons, respectively. The proton and deuteron spectra are extended up to the energies 120–130 MeV. (auth)

30699 MEASUREMENT OF MEAN LIVES IN ^{13}C AND ^{10}B BY THE RECOIL DISTANCE METHOD. Gallmann, A.; Frick, G.; Heusch, B.; Haas, F.; Warburton, E. K. (Laboratoire de Physique Nucleaire, Strasbourg. Laboratoire d'Instrumentation Nucleaire, Strasbourg). Nucl. Phys.; A143: 326-36(1970). (In French).

The recoil-distance measurements of lifetimes of excited states produced in the $^{10}B(\alpha,p)^{13}C$ and $^7Li(\alpha,n)^{10}B$ reactions are reported. The mean lives determined are as follows: ^{13}C 3.85-MeV level: $\tau_m = 9.9 \pm 0.9$ ps, ^{10}B 2.15-MeV level: $\tau_m = 2.15 \pm 0.45$ ps. These results are compared to previous Doppler-shift attenuation method measurements. (auth)

30700 PHOTOPROTONS FROM NUCLEUS ^{11}B. Sorokin, Yu. I.; Shardanov, A. Kh.; Shevchenko, V. G.; Yur'ev, B. A. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 11: 8-18 (1970). (In Russian).

Energy distributions were measured of photoprotons emitted from the ^{11}B nuclei exposed to bremsstrahlung γ radiation with $E_{\gamma max} = 16.5$ and 18.5 MeV, as well as the angular distributions of photoprotons of $E_{\gamma max} = 18.5$ MeV. The protons were registered in nuclear photoplates. In the photoproton spectra a great number of maxima were observed that are due to the excitation of levels of the ^{11}B nucleus in the energy region from 12 up to 18.5 MeV. The cross sections were obtained for the reaction $^{11}B(\gamma,p)^{10}Be$ with the ^{10}Be in the ground state and in the first excited state. Radiation

widths of the observed levels of ^{11}B were estimated. The analysis of the results enables one to deduce multipolarities of the γ transitions as well as spins and parities of the excited states of the ^{11}B nucleus. (auth)

30701 MIRROR REACTIONS $^{12}C(^3He,^3He')^{12}C$ AND $^{12}C(^3He,t)^{12}N$. Artemov, K. P.; Glukhov, Yu. A.; Gol'dberg, V. Z.; Davydov, V. V.; Petrov, I. P.; Rudakov, V. P. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 11: 43-7(1970). (In Russian).

Differential cross sections are measured for the mirror reactions $^{12}C(^3He, ^3He')^{12}C$ and $^{12}C(^3He, t)^{12}N$ at the ^3He-ion energy 36 MeV. Direct evidence is presented that the states of the ^{12}C nucleus with energies 15.1 MeV (1^+, T = 1) and 16.1 MeV (2^+, T = 1) are analogous to the ground state (1^+) and the first excited state (0.95 MeV) of the ^{12}N nucleus. So, the 0.95-MeV level of ^{12}N has the quantum numbers 2^+. It is found that the admixture of the T = 0 state to the 15.1-MeV state of ^{12}C is no more than 3% in the amplitude. The same admixture to the 16.1-MeV state of ^{12}C is also, very likely, no more than a few percent. (auth)

30702 THE D-PARAMETER FOR PROTON–NUCLEUS SCATTERING AT 50 MeV. Batty, C. J.; Tschalaer, C. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys.; A143: 151-9(1970).

The depolarization parameter D for the elastic scattering of 50 MeV polarized protons from ^{10}B, ^{27}Al, ^{59}Co In(nat) and ^{209}Bi is measured near the first minimum in the differential scattering cross section, with rms uncertainties of ±6% to ±15%. Target thicknesses corresponding to 1 to 3 MeV energy loss are used. No significant deviation of D from unity is observed. (auth)

30703 DIRECT REACTIONS INDUCED BY ^{14}N ON ^{12}C AT 78 MeV. Von Oertzen, W.; Liu, M.; Caverzasio, C.; Jacmart, J. C.; Pougheon, F.; Riou, M.; Roynette, J. C.; Stephan, C. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A143: 34-52(1970).

Direct reactions induced by ^{14}N on ^{12}C at 78 MeV are studied. Angular distributions of the inelastic scattering and transfer of one and two nucleons have been measured. The DWBA analysis of the transfer based on the theory of Buttle and Goldfarb extended well above the Coulomb barrier has been performed. Using the Barshay and Temmer theorem, the isospin conservation in one-nucleon transfer reactions between heavy ions has been tested. (auth)

30704 NUCLEAR STRUCTURE STUDY OF ^{19}F LEVELS FROM THE $^{18}O(^3He,d)^{19}F$ REACTION. Green, L. L.; Lennon, C. O.; Naqib, I. M. (Oliver Lodge Lab., Liverpool). Nucl. Phys.; A142: 137-60(1970).

Angular distributions were measured for twenty deuteron groups from the $^{18}O(^3He,d)^{19}F$ reaction at 11.0-MeV ^3He energy. The spectroscopic information obtained on even-l transitions is compared with recent shell-model intermediate coupling calculations as well as rotational particle coupling calculations. Good agreement between experiment and both models is observed for most of the strongly excited positive parity states. It is suggested that the lowest T = $\frac{3}{2}$ state in ^{19}F lies at 7.56 ± 0.03 MeV and that the $\frac{1}{2}^+$ level at 6.25 ± 0.03 MeV be identified with the Nilsson proton orbit 11. The l = 1 transitions to the low-lying negative parity states are analyzed in terms of core excitation configurations in the ^{18}O ground state and in ^{19}F. (auth)

30705 ELASTIC AND INELASTIC SCATTERING OF 14.2 MeV NEUTRONS FROM ^6Li AND THE OPTICAL MODEL. Abbondanno, U.; Giacomich, R.; Granata, L.; Lagonegro, M.; Poiani, G. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nuovo Cim.; 66A: 139-51(1 Mar 1970).

The differential cross sections for the elastic scattering of 14.2-MeV neutrons and for inelastic scattering to the first excited level were measured for ^6Li, using a time-of-flight spectrometer. The elastic and the inelastic angular distribution leading to the 2.18-MeV level were obtained; the elastic one was compared with the predictions of the optical model with parameters similar to those used for fitting medium weight and heavy nuclei gave the best fit. The derived values for the total elastic and for the inelastic to the first-excited-state cross sections are (754 ± 82) mb and (83 ± 30) mb, respectively. (auth)

30706 ELECTROEXCITATION OF THE GIANT RESONANCE IN ^{12}C. Torizuka, Y.; Yamaguchi, A.; Nakahara, K.; Oyamada, M.; Terasawa, T.; Itoh, K.; Kojima, Y.; Kimura, M. (Tohoku Univ., Sendai). Phys. Rev.; 188: 1745-6(20 Dec 1969).

The cross section for electroexcitation of the giant resonance region in ^{12}C was measured using incident electron beams of 177 and 250 MeV. The spectrum excited by the Coulomb interaction was quite similar to the result obtained from the $^{12}C(\gamma,n)^{11}C$ reaction. The experimental data were compared with the theoretical predictions based on the particle-hole model. (auth)

30707 DEUTERON-INDUCED REACTIONS IN ^6Li, ^9Be, AND ^{10}B AT BOMBARDING ENERGIES OF 4.5 TO 6.0 MeV. Powell, D. L.; Crawley, G. M.; Rao, B. V. N.; Robson, B. A. (Australian National Univ., Canberra). Nucl. Phys.; A147: 65-80(1970).

Angular distributions for the reactions $^6Li(d,p)^7Li$ (ground state and 0.48 MeV level), $^9Be(d,p)^{10}Be$ (ground state and 3.37 MeV level), $^{10}B(d,p)^{11}B$ (ground state, 2.12, 4.44 and 5.02 MeV levels) and the elastic scattering of deuterons on ^6Li and ^9Be have been measured for bombarding energies between 4.5 and 6.0 MeV. Absolute cross sections have been obtained for the ^9Be + d data. An analysis of the data has been made using the optical-model and the distorted-wave and Hauser–Feshbach theories. (auth)

30708 LOW-LYING T = 2 STATES OF ^{16}O. Adelberger, E. G. (Stanford Univ., Calif.); Nero, A. V.; McDonald, A. B. Nucl. Phys.; A143: 97-108(1970).

The excitation energies of the lowest two T = 2 states in ^{16}O are found to be 22.717 ± 0.008 MeV (Γ < 30 keV) and 24.522 ± 0.011 keV (Γ < 50 MeV) using the $^{14}C(^3He,n)$ reaction. These energies are in excellent agreement with elementary Coulomb energy calculations which are quite successful in other T = 2 and T = $\frac{3}{2}$ isobaric multiplets. Double stripping angular distributions indicate that the 24.52 MeV state has $J^\pi = 2^+$. In a $^{12}C(^3He,n)$ measurement, the excitation energy of the fourth excited state of ^{14}O is determined to be 6.585 ± 0.005 MeV. Some systematics of T = 2 and T = $\frac{3}{2}$ levels are discussed. (auth)

30709 POLARIZATION OF PROTONS PRODUCED IN INTERACTIONS BETWEEN 650- TO 840-MeV PHOTONS AND ^7Li AND ^{12}C NUCLEI. Tonapetyan, S. G.; Konovalov, O. G.; Derebchinskii, A. I.; Zybalov, A. A.; Khvorostyan, V. M.; Goncharov, N. V.; Gold'shtein, V. A. (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.); 11: 101-3(5 Feb 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 165-8 (5 Feb 1970).

Measurements were made of the polarization of protons emitted at a laboratory angle 41° in reactions between 650- to 840-MeV photons and ^7Li and ^{12}C. Both kinematic regions, with and without photoproduction of pions on the free nucleon, were covered. The proton polarization in the meson region II changes strongly with photon energy, while it is close to zero in the other region. (D.L.C.)

30710 ASYMMETRIES FROM DOUBLE SCATTERING OF FAST NEUTRONS BY ^{12}C. Fasoli, Umberto; Scotoni, Igino; Toniolo, Domenico; Zago, Guido (Univ., Padua). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 46: 725-9(Jun 1969).

The absolute values of the analyzing power of carbon-12 between 2 and 3 MeV, obtained by a double scattering experiment, are discussed. Of the two successive scatterings by two carbon scatterers, the first one acts as a polarizer and the second one as an analyzer. (L.W.A.)

30711 PRODUCTION OF ^8Li AND ^8B NUCLEI WITH DOUBLE CHARGE EXCHANGE OF π^--MESONS. Batusov, Yu. A.; Zalikhanov, B. Zh.; Sidorov, V. M.; Tuvdendorzh, D.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 736-40(Apr 1970). (In Russian).

From 30,000 interactions $\pi^- + Z \rightarrow \pi^+ + Z' + \ldots$ with 200–300-MeV incident pions 120 stars were selected with production of ^8Li and ^8B nuclei. Energy and angular distributions of ^8Li were measured and total cross sections of the process were determined. The kinematical analysis was carried out. As a result the following reactions are identified: $\pi^- + {}^{12}C \rightarrow \pi^+ + {}^8Li + {}^3H + n$, $\pi^- + {}^{14}N \rightarrow \pi^+ + {}^8B + 6n$, $\pi^- + {}^{16}O \rightarrow \pi^+ + {}^8Li + {}^6He + {}^1H + n$. (auth)

30712 MECHANISM OF THE REACTION $^{14}N(\alpha,p)^{17}O$ AND STRUCTURE OF LOW LYING STATES OF THE ^{17}O NUCLEUS. Zelenskaya, N. S.; Karabonov, N. V.; Spasskii, A. V.; Tarov, K. G.; Teplov, I. B.; Fateeva, L. N. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 11: 722-31(Apr 1970). (In Russian).

Differential cross sections for proton emission from the reaction $^{14}N(\alpha,p)^{17}O$ with the final nucleus in the ground state and in three lowest excited states are measured for θ_{lab} = 30, 90, and 158° in the α-particle energy region from 10 up to 25 MeV. Angular distributions are also measured at ten values of the α-particle energy. The mechanism of the reaction is discussed. The deduction is that the reaction at the energy 10–15 MeV proceeds mainly through formation and decay of the intermediate nucleus, while at 25 MeV the mechanism is the direct process. Analysis of the structure of the low-lying ^{17}O levels with negative parity shows that the level $\frac{1}{2}^-$ (3.06 MeV) has the configuration $(1p)^{-1}(1d-2s)^2$. (auth)

30713 EXTENDED MODEL DESCRIPTION OF ^{19}F AND ^{20}Ne. McGrory, J. B. (Oak Ridge National Lab., Tenn.). Phys. Lett.; 31B: 339-43(16 Mar 1970).

A model for light s–d shell nuclei which is capable of accounting for all low-lying even and odd parity states is extended to ^{19}F and ^{20}Ne. The calculated spectra are in good agreement with experiment. The calculations of transition strengths for E3-electromagnetic transitions and unique first-forbidden beta decays in these nuclei are discussed. (auth)

30714 LIFETIME OF THE FIRST EXCITED STATE IN ^{30}S AND E2 STRENGTHS IN MASS-30 NUCLEI. Bini, M.; Bizzeti, P. G.; Bizzeti-Sona, A. M.; Mando, M.; Maurenzig, P. R. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Lett. Nuovo Cim.; 3: 235-8(19 Feb 1970).

The E2 transition strength of analog γ transitions in sulfur-30 is investigated in order to solve the ambiguity in the ratio of the isovector to the isoscalar transition amplitude. The lifetime of the first excited state is deduced from Doppler-shift attenuation, and is found to be close to what can be expected on the basis of isospin invariance. (L.W.A.)

30715 KNOCK OUT OF FAST ^{3}He AND ^{4}He FRAGMENTS FROM LIGHT NUCLEI BY 665-MeV PROTONS. Komarov, V. I.; Kosarev, G. E.; Savchenko, O. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 711-21(Apr 1970). (In Russian).

The yield of ~530-MeV ^{3}He nuclei knocked out from ^{6}Li, ^{9}Be, ^{12}C, ^{16}O at an angle 5.4° to the direction of 665-MeV proton beam is measured. The yield of ~470 MeV ^{4}He is measured under the same conditions; besides that the differential cross section is measured of proton elastic scattering by free nuclei of ^{3}He, ^{4}He at an angle 169° in c.m.s. The maximum observed in the measured region of spectra of ^{3}He and ^{4}He knocked out from ^{6}Li and ^{9}Be is interpreted as a result of proton quasielastic scattering by three- and four-nucleon associations in nuclei. The estimate of the total effective number of such associations is compared with the calculation results in terms of the shell model. The applicability of the fluctuation theory to the explanation of the knock out of fast ^{3}He and ^{4}He fragments is discussed. (auth)

30716 DO THREE α-PARTICLES MAKE A ^{12}C? Noble, J. V. (Univ. of Pennsylvania, Philadelphia). Phys. Lett.; 31B: 253-5 (2 Mar 1970).

This note answers two questions: (1) What is the binding energy of three "elementary" α-particles, interacting via the empirical $\alpha-\alpha$ potential; and (2) why do the various previous calculations of this model of ^{12}C disagree? (auth)

30717 STUDY OF 2^- STATES IN ^{16}O AT 19.04 AND 20.36 MeV BY INELASTIC ELECTRON SCATTERING. Goldmann, A.; Stroetzel, M. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett.; 31B: 287-8(2 Mar 1970).

Levels in ^{16}O at 19.04 ± 0.05 and 20.36 ± 0.07 MeV were identified as 2^-, with total widths of 400 ± 50 and 500 ± 100 keV, and ground state radiative M2 widths of 1.5 ± 0.3 and 2.9 ± 1.0 eV, respectively. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 29308, 29506, 29545, 29576, 29611, 30647, 30651, 30684, 30685, 30694–30696, 30702, 30713, 30843, and 30935.

30718 (ANU-P-469) THE LOWEST T = 2 STATE AT 5.989 MeV IN ^{28}Al. Clark, G. J.; Treacy, P. B.; Tucker, S. N. (Australian National Univ., Canberra. Research School of Physical Sciences). [nd]. 7p. Dep. CFSTI (U. S. Sales Only).

Comparison of the ratio of yields of the ^{26}Mg(^{3}He,p)^{28}Al and ^{27}Al(d,p)^{28}Al transitions shows a strong enhancement for transitions to the 5.989 MeV state of ^{28}Al. This, and the (^{3}He,p) angular distribution, support an assignment T = 2 for this level. (Australia)

30719 (CEA-R-3948) A STUDY OF THE DETAILED VARIATIONS OF NUCLEAR RADIUS IN THE REGION $40 \leq A \leq 62$ BY MEANS OF ELASTIC SCATTERING OF 42 MeV α PARTICLES ON ^{40,42,44,48}Ca, ^{46,48,50}Ti, ^{52}Cr, ^{54,56}Fe, ^{58,60,62}Ni. Fernandez, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1970. 99p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, Orsay, France.

Angular distributions of 42 MeV α particles, elastically scattered on ^{40,42,44,48}Ca, ^{46,48,50}Ti, ^{52}Cr, ^{54,56}Fe, ^{58,60,62}Ni were measured in the forward region with an absolute accuracy of ±0.1 degree; in particular, the positions of the minima near 35 degrees (center of mass system) have been determined within ±0.1 degree. The theoretical analysis was done in three ways using: the Fraunhofer model, a direct parameterization of the scattering amplitude in terms of 3 parameters, and a standard 4-parameter optical model. Strong absorption radii were deduced from the critical angular momenta extracted from the scattering amplitudes. In addition attempts were made to determine, for the optical model analysis, other sorts of strong absorption radii which are more characteristic of the scattering than the usual midpoint radius of the potential. Furthermore, in the region where its depth is smaller than 6 or 7 MeV (which corresponds to distances of the order of the strong absorption radii) the optical potential appears to be well determined and free of the ambiguities associated with the usual parameters. The rate of increase of almost all strong absorption radii is smaller within the Ca isotopes and within the Ti isotopes than within the Fe and Ni isotopes, the radius of ^{48}Ca being particularly small in all but one type of analysis. (France)

30720 (CNEA-240) COLLECTIVE STATES OF EVEN NUCLEI WITH QUADRUPOLAR DEFORMATION. Suarez, Jose F. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1969. 19p. (In Spanish). Dep. CFSTI (U. S. Sales Only)

Surface vibrations of even nuclei with quadrupole deformation are taken into account to compute the contribution of rotations to nuclear spectra. The complete range $0 \leq \gamma_0 \leq 30^0$ is covered with the same solution for the Hamiltonian equation. The agreement with the small vibrations hypothesis is better than that obtained with previous models. (auth)

30721 (INR–1147) CROSS SECTIONS FOR THE ^{89}Y(n,n')^{89m}Y AND ^{89}Y(n,2n)^{88}Y REACTIONS. Abboud, A.; Decowski, P.; Grochulski, W.; Marcinkowski, A.; Siwek, K.; Turkiewicz, I.; Wilhelmi, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 12p. Dep. CFSTI(U. S. Sales Only).

The excitation curves for the ^{89}Y(n,n')^{89m}Y reaction were measured in the neutron energy range 3 to 18 MeV, and for the ^{89}Y(n,2n)^{88}Y reaction in the energy range 13 to 18 MeV. The results obtained were interpreted in terms of the statistical nuclear reaction model. The problem of competition of the electromagnetic radiation emission with respect to the neutron emission from the highly excited compound nucleus states is discussed. (auth)

30722 (INR–P–1105) ISOMERIC CROSS-SECTION RATIOS AND TOTAL CROSS SECTIONS FOR THE ^{74}Se/n,2n/^{73g,m}Se, ^{90}Zr/n,2n/^{89g,m}Zr AND ^{92}Mo/n,2n/^{91g,m}Mo REACTIONS. Abboud, A.; Decowski, P.; Grochulski, W.; Marcinkowski, A.; Piotrowski, J.; Siwek, K.; Wilhelmi, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 33p. Dep. CFSTI (U. S. Sales Only).

The isomeric ratios and excitation functions were measured for the ^{74}Se/n,2n/^{73g,m}Se, ^{90}Zr/n,2n/^{89g,m}Zr and ^{92}Mo/n,2n/^{91g,m}Mo reactions in the neutron energy range 12–18 MeV. The results are compared with the statistical model predictions. Calculations were performed with the use of the superconductivity model of nuclear level density for closed shell nuclei. In the case of the ^{90}Zr/n,2n/^{89g,m}Zr and ^{92}Mo/n,2n/^{91g,m}Mo reactions the calculated isomeric ratios show good agreement with experimental data, which is not true, however, for the ^{74}Se/n,2n/^{73g,m}Se reaction. To obtain agreement between the experimental and theoretical isomeric ratios for the latter reaction some changes in the decay scheme of the ^{73}Se nucleus seem to be necessary. For all the reactions investigated the calculated total cross sections do not agree with the measured ones. The disagreement may be due to the fact that no account was taken of the gamma-neutron competition. (auth)

30723 (KFK–1114) MEASUREMENT OF AND CALCULATION OF STRENGTH FUNCTION VALUES FOR NUCLEI IN THE AREA OF 3s RESONANCE. Mueller, K.-N.; Rohr, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Nov 1969. 76p. (In German). Dep. CFSTI (U. S. Sales Only).

Total neutron cross sections of the isotopes ^{49}Ti and ^{53}Cr were measured in the energy range of 17-250 keV at the Karlsruhe Van de Graaff accelerator, and analyzed with an R-matrix multilevel formula to obtain the resonance parameters. A spin-independent strength function value of 3.2 ± 0.7 was obtained for ^{49}Ti and 4.1 ± 0.9 for ^{53}Cr. The analysis of the cross section above 120 keV indicates a spin dependence of the ^{53}Cr strength function. To investigate the fluctuations of experimental strength function values around the average curve described by the optical model, strength functions were calculated for 20 nuclei in the region of the 3 s resonance. The calculations are based on a semi-empirical ansatz and explain the fluctuations as varia-

tions of the doorway-state density in the binding-energy region. The density of these states was calculated in the framework of a shell model. Pairing correlations were taken into account according to the superconductivity theory of the nucleus. (auth)

30724 (LUNP–6907) ENERGY LEVELS IN ^{58}Co. Erlandsson, B.; Marcinkowski, A. (Lund Univ. (Sweden). Dept. of Physics). Nov 1969. 55p. Dep. CFSTI (U. S. Sales Only).

^{57}Fe was bombarded with protons and 114 peaks in the yield curve for the reaction ^{57}Fe(p,γ)^{58}Co were observed in the range of proton energy from 1150 keV to 1575 keV. Gamma-ray measurements were performed with a Ge(Li) detector and the decay scheme studied with a coincidence spectrometer. A decay scheme with 30 excited levels and 52 transitions is proposed. The excited states are discussed and compared with shell-model calculations. The integrated experimental spectrum of primary gamma-rays was compared with the statistical primary gamma-ray spectrum. (Sweden)

30725 PROTON POLARIZATION IN ELASTIC AND INELASTIC SCATTERING ON ^{25}Mg AT E_p = 6.08 MeV. Chubinskii, O. V.; Vaganov, P. A.; Gustova, L. V.; Gushchin, V. N.; Kuz'mitskii, I. V.; Serebrov, A. P. (Leningrad State Univ.). Yadern. Fiz.; 11: 29-32(1970). (In Russian).

The polarization angular distribution of 6.08 MeV protons elastically scattered by ^{25}Mg was measured in the interval 30 to 150° (lab. system) using the double scattering method. Experimental results are compared with calculations by means of the optical model. The value of the polarization of inelastically scattered protons corresponding to the states 1.614 MeV ($^1/_2^+$) and 1.960 MeV ($^5/_2^+$) is obtained at the angles θ = 60, 70, 80, 90, 100 and 140°. (auth)

30726 A PULSED NEUTRON DETERMINATION OF THE THERMAL NEUTRON ABSORPTION CROSS-SECTION OF ^{59}Co. Silk, M. G.; Wade, B. O. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy; 24: 43-9(Feb 1970).

The pulsed neutron technique was used to determine the thermal neutron absorption cross section of ^{59}Co by measurement in solutions of $CoSO_4$ in reactor grade D_2O. The combined best estimate for the ^{59}Co cross section was 37.245 ± 0.11 barn at 2200 m/sec. When previous measurements were analyzed and combined with the experiment a best estimate of 37.34 ± 0.09 barn was proposed. The pulsed neutron measurements yielded values for the diffusion coefficient of poisoned D_2O which were consistent with previously reported values. (UK)

30727 MEASUREMENTS OF PRECISE INTERNAL CONVERSION COEFFICIENTS WITH AN IN-BEAM SPECTROMETER. Robert, K. Q.; Linn, J. R.; Durham, F. E. (Tulane Univ., New Orleans). Nucl. Instrum. Methods; 79: 251-8(1970).

A technique is described in which the NPG method is applied to the measurement of internal conversion coefficients of prompt transitions following nuclear reactions. An intermediate-image electron spectrometer and a Ge(Li) detector were used to observe simultaneously internal conversion electrons and gamma-rays produced during proton bombardment of thin targets placed at the source position of the spectrometer. With the value α_T = (9.1 ± 0.2) × 10^{-2} for the 662 keV transition in ^{137}Ba accepted as a standard, the total internal conversion coefficient of the 843 keV ($^1/_2^+ \rightarrow {}^5/_2^+$) ground-state transition of ^{27}Al, populated through the (p,p′) reaction, was found to be α_T = (4.6 ± 0.3) × 10^{-5}. This value is in excellent agreement with the theoretical E2 value. The total internal conversion coefficient of the 413 keV ($^1/_2^- \rightarrow {}^3/_2^-$) ground-state transition in ^{55}Fe, populated through the ^{55}Mn(p,n)^{55}Fe reaction, was measured to be α_T = (9.4 ± 0.8) × 10^{-4}. This value implies a nearly pure M1 character for the 413 keV transition. The technique described can readily be extended to other transitions populated in nuclear reactions. (auth)

30728 COMPARISON OF ELASTIC DEUTERON SCATTERING FROM NEIGHBOURING NUCLEI. Fitz, W.; Heger, J.; Santo, R.; Wenneis, S. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; A143: 113-20(1970).

The elastic scattering of 11.8 MeV deuterons on isotopes of various nuclei between Al and Ni having been measured and analyzed in terms of the optical model is discussed. The data show significant differences between neighboring isotopes of the same element, particularly for lighter target nuclei. In the optical-model analysis this behavior is reflected in variations of the imaginary potential parameters. The difference in the angular distributions of neighboring isotones are found to be much smaller. Obviously, this behavior cannot be explained by an isospin dependent potential as in the case of proton scattering, where similar effects have been observed. Some correlations between imaginary potential and β_2 values extracted by DWBA analysis of inelastic scattering from the first excited 2^+ states are indicated. (auth)

30729 THE LOWEST T = 2 STATE AT 5.989 MeV IN ^{28}Al. Clark, G. J.; Treacy, P. B.; Tucker, S. N. (Australian National Univ., Canberra). Nucl. Phys.; A143: 109-12(1970).

Comparison of the ratio of yields of the ^{26}Mg(^{3}He,p)^{28}Al and ^{27}Al(d,p)^{28}Al transitions shows a strong enhancement for transitions to the 5.989 MeV state of ^{28}Al. This, and the (^{3}He,p) angular distribution, support an assignment T = 2 for this level. (auth)

30730 THE LEVEL STRUCTURE OF ^{71}Ge. Malan, J. G.; Tepel, J. W.; De Villiers, J. A. M. (Atomic Energy Board, Pelindaba, S. Afr.). Nucl. Phys.; A143: 53-64(1970).

The level structure of ^{71}Ge was investigated by observing both neutrons and decay gamma rays produced in the reaction ^{71}Ga (p,nγ)^{71}Ge at incident proton energies between 1.5 and 3.1 MeV. The excitation energies of a large number of levels below 2 MeV were accurately determined. A level scheme was constructed for ^{71}Ge. Branching ratios and probable spin assignments for a number of levels are presented. (auth)

30731 SOURCE OF CIRCULARLY POLARISED PHOTONS. Logan, B. A. (Univ. of Ottawa). Nucl. Instrum. Methods; 80: 345-6(1970).

The inelastic scattering of a low energy polarized proton beam is suggested as a source of circularly polarized photons. (auth)

30732 LOW-LYING LEVELS IN ^{25}Na. Becker, J. A.; McDonald, R. E.; Chase, L. F. Jr.; Kohler, D. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Phys. Rev.; 188: 1783-91 (20 Dec 1969).

Information about the 90-, 1068-, 2201-, 2417-, 2788-, 2914-, and 3353-keV levels in ^{25}Na was obtained by measuring γ-ray angular correlations in a collinear geometry. The ^{26}Mg(t,α)^{25}Na reaction was used to populate the levels of ^{25}Na at an incident triton energy of 2.6 MeV. NaI(Tl) detectors were used for γ-ray spectroscopy. γ-ray angular correlations were obtained by measuring the yield of γ rays at angles between 0° and 90° in coincidence with reaction-produced α particles detected near 180° with respect to the incident-beam direction. The α-γ coincidence data were collected employing two-parameter analysis. γ-ray branching data were obtained for all the levels mentioned above, and angular correlations were extracted from these data for γ rays from the decay of the 1068-, 2201-, 2914-, and 3353-keV levels. Analysis of these data resulted in a definite spin assignment for only one level: J = $^3/_2$ for the 2201-keV level. The spin of the 90-keV level was restricted to either J = $^3/_2$ or $^5/_2$, while the 2914- and 3353-keV levels have spin J ≥ $^3/_2$. The angular correlation of the 979-keV γ ray following the decay of the 1068-keV level was found to be isotropic, supporting the J = $^1/_2$ assignment to this level. More information about the γ-ray branching modes of these levels was obtained using the ^{23}Na(t,pγ)^{25}Na reaction. A Ge(Li) γ-ray spectrometer located at 90° to the beam direction was used to measure γ-ray pulse-height distributions coincident with reaction-produced protons. Two-parameter techniques were used. Intensity ratios γ_0/γ_1 of γ-ray transitions to the ground and the first excited states were extracted from these spectra; γ_0/γ_1 was found to be 0.13 ± 0.01, 2.6 ± 0.2, >12, >50, <0.04, 4 ± 1, and 0.23 ± 0.02 for the 1068-, 2201-, 2417-, 2788-, and 2914-keV levels, respectively. We also report some other transitions in ^{25}Na. Measured γ-ray energies are compared with transition energies computed from ^{25}Na energy levels quoted by Hinds, Marchant, and Middleton; good agreement was obtained, and as a result, level energies (in keV) for ^{25}Na of 90 ± 1, 1068 ± 2, 2201 ± 2, 2417 ± 3, 2788 ± 3, 2914 ± 4, 3353 ± 3, 3455 ± 7, 3685 ± 4, 3928 ± 7, 3950 ± 4, and 3995 ± 5 were adopted. An upper limit $\tau_m \leq 20 \times 10^{-9}$ sec was determined for the lifetime of the levels mentioned above. Several of these low-lying states are tentatively described in terms of the shell model. (auth)

30733 USE OF THE (γ,γ') REACTION FOR STUDYING THE ENERGY LEVELS OF ^{75}As. Moreh, R.; Shahal, O. (Negev Nuclear Research Centre, Beer-Sheva, Israel). Phys. Rev.; 188: 1765-70(20 Dec 1969).

Elastic and inelastic nuclear resonant scattering of monochromatic photons from ^{75}As was studied using a 47-cc Ge(Li) detector. The γ source was provided by thermal-neutron capture in iron. The energy of the resonance level in ^{75}As was found to be 7.646 MeV. Assuming the high-energy lines to be primary transitions deexciting the resonance level, 25 energy levels were found from the ground state up to 2.6 MeV, seven of which may be identified with recently reported levels. By measuring the angular distribution of the scattered radiation, the spin of the scattering level was determined to be $^1/_2$ and the spins of 14 low-lying levels were thus found to be either $^1/_2$ or $^3/_2$. The total radiative width of the resonance level was determined and was found to be Γ = 0.36 ±

0.10 eV and $\Gamma_0/\Gamma = 0.11$. The ^{75}As levels are compared with the predictions of the Coriolis coupling model. (auth)

30734 YIELDS OF RADIONUCLIDES PRODUCED IN THICK TARGETS BOMBARDED WITH 3.0-GeV ELECTRONS. Fulmer, C. B. (Oak Ridge National Lab., Tenn.); Williams, I. R.; Toth, K. S.; Dell, G. F. Phys. Rev.; 188: 1752-7(20 Dec 1969).

Thick targets of aluminum, iron, and lead were bombarded with 3.0-GeV electrons. γ-ray spectra of the bombarded samples were measured with a Ge(Li) spectrometer. These spectra were used to determine yields of individual radionuclides as a function of depth in the targets. The target thickness at which the yield curves peak decreases with the number of charged particles emitted from the target nucleus. The target thicknesses at which the yield curves peak were used to obtain estimates of the dominant photon energies for the production of each nuclide. (auth)

30735 RADIOACTIVE NUCLIDES ^{79}Ge AND ^{82}As. Karras, M.; Ward, T. E.; Ihochi, H. (Univ. of Arkansas, Fayetteville). Contract AT(10-1)-3235. Nucl. Phys.; A147: 120-8(1970).

The irradiation of enriched ^{82}Se with 14.7-MeV neutrons was found to produce two new activities with half-lives: 13.7 ± 0.8 sec and 42 ± 2 sec which were assigned to ^{82}As and ^{79}Ge, respectively. The decay characteristics of the two new nuclides were studied using a Ge(Li) spectrometer as well as with β- and γ-scintillation detectors. (auth)

30736 THE ^{30}Si(^{3}He,α)^{29}Si REACTION AT 8.0 AND 7.0 MeV. McQueen, J. E. Jr.; Joyce, J. M.; Ludwig, E. J. (Univ. of North Carolina, Chapel Hill. Triangle Universities Nuclear Lab., Chapel Hill, N. C.). Nucl. Phys.; A147: 81-93(1970).

Measurements of the angular distribution of α particles from the ^{30}Si(^{3}He,α)^{29}Si reaction at E(^{3}He) = 8.0 and 7.0 MeV and excitation curves for E(^{3}He) = 6.8 to 8.2 MeV are reported. The ^{30}Si(^{3}He, ^{3}He) elastic scattering angular distributions at 8.0 and 7.0 MeV are also reported. Statistical analysis of the excitation curve data, optical-model analyses of the elastic scattering and DWBA analyses of the reaction angular distributions have been performed and spectroscopic factors extracted. (auth)

30737 A STUDY OF THE GIANT DIPOLE STATES OF ^{28}Si, ^{32}Si, AND ^{40}Ca. Wu, C.-P.; Firk, F. W. K.; Phillips, T. W. (Yale Univ., New Haven). Nucl. Phys.; A147: 19-32(1970).

The 90° differential cross sections for the ground-state reactions ^{28}Si(γ,n_0)^{27}Si, ^{32}S(γ,n_0)^{31}S, and ^{40}Ca(γ,n_0)^{39}Ca were measured using a nanosecond time-of-flight spectrometer with a resolution of 0.25 ns · m^{-1}. Pronounced structure is observed in the three reactions at excitation energies which correspond to the giant dipole resonance regions. The results are compared with (p,γ_0) and (γ,p_0) data to test whether or not the cross sections are due to resonances or statistical fluctuations and to study possible isospin mixing effects. Strong correlations are observed between the energies and widths of intermediate-type structure in all three cases. Pseudo cross-section calculations were also carried out using the Thomas reduced R-function theory to generate fluctuations and the results then compared with the experimental data. It is concluded that in ^{28}Si the cross section is dominated by fluctuations whereas in ^{32}S and ^{40}Ca, there is evidence supporting some resolved resonance effects. (auth)

30738 INTERNAL BREMSSTRAHLUNG ACCOMPANYING THE POSITON DECAY OF ^{82}Rb. Akelsson, Roland; Persson, Boerje (Lund Inst. of Tech., Sweden). Nucl. Phys.; A138: 631-43(1969).

The internal bremsstrahlung from the positron decay of ^{82}Rb was measured in the energy ranges 0.95 to 1.3 and 1.7 to 2.0 MeV. The measured intensity was about twice the value predicted by the charge-independent theory. The external bremsstrahlung produced in stopping the positrons in Be, C, and Al was measured in the same energy intervals. Energies and intensities of the γ rays from ^{82}Rb were determined, and a revised energy level diagram is proposed for ^{82}Kr. Some of the γ rays were observed for the first time. (auth)

30739 SHORT-RANGE CORRELATIONS IN ^{40}Ca. Wright, L. E. (Duke Univ., Durham, N. C.); Tuan, Shiang-tai; Huber, M. G. Lett. Nuovo Cim.; 3: 253-6(19 Feb 1970).

The dependence of electron scattering data on the detailed form of the correlation function is applied to analyze the elastic scattering of 750-MeV electrons from calcium-40. (L.W.A.)

30740 THE STRUCTURE OF THE 5280 AND 5950 keV STATES OF ^{30}Si. Durell, J. L.; Symes, R. D. (Univ. of Liverpool). Phys. Lett.; 31B: 358-60(16 Mar 1970).

The mean lives of the states in ^{30}Si at 5280 and 5950 keV excitation energy were measured to be 142 ± 15 and 21 ± 12 fs, respectively. An angular correlation experiment determined their spins and parities as 4^+. It is suggested that the 5950-keV level is the collective 4^+ state associated with the ground state of ^{30}Si. (auth)

30741 OBSERVATION OF AN 8^- LEVEL IN ^{20}Ne. Panagiotou, A. D. (Univ. of Rochester, N. Y.). Phys. Lett.; 31B: 361-2(16 Mar 1970).

A state in ^{20}Ne at 15.62 MeV excitation was found. From the systematics of its cross section, it appears to be an unnatural parity state and may be the spin 8 member of the $K^\pi = 2^-$ rotational band of (82) SU_3 symmetry. (auth)

30742 THEORY OF NONNORMAL PARITY SPECTRA OF NUCLEI IN THE A = 40 REGION. Goode, Philip Ranson. New Brunswick, N. J.; Rutgers-The State Univ. (1969). 154p.

Thesis.

The spectral properties of nuclei in the A = 40 region are investigated. Explicitly, the nuclear states of nonnormal parity (parity opposite to that of the ground state) are studied in terms of a microscopic core-particle coupling model. This treatment is applied to ^{39}Ca, ^{39}K, ^{41}Ca and ^{42}Ca using a realistic interaction. The core states are taken to be the Random Phase Approximation (RPA) states in ^{40}Ca. It is found that the weak coupling model, in which one assumes a given state to be a particle (hole) coupled to only one vibration, is not valid, but rather two vibrations are usually important, namely the lowest $J = 3^-$ and 5^- states of ^{40}Ca. It is noted that the concept of a particle coupled to a vibration is ambiguous; for example, a $1f_{\frac{7}{2}}$ particle coupled to a 3^- vibration is not orthogonal to a $1f_{\frac{5}{2}}$ particle coupled to a 5^- vibration. This non-orthogonality is handled correctly in this microscopic theory and is quite important in calculating transition rates. This non-orthogonality effect could not be treated in a phenomenological theory. The resultant spectral properties in this extended core-particle coupling model represent a significant improvement over those of the corresponding shell model calculations. In ^{39}K, the calculated transition rates are in good agreement with experiment. In addition, the marked contrast between the odd parity spectral quantities of ^{40}Ca and ^{42}Ca is reproduced. An attempt was made to apply this core-particle coupling model in the A = 56 region, however, it is shown that ^{56}Ni is an unsatisfactory core nucleus. It is further shown that the low-lying normal parity states of ^{56}Ni and ^{56}Co can be described as a combination of 1p-1h and 2p-2h states. (Diss. Abstr. Int., B)

30743 EXPERIMENTAL DETERMINATION OF (μ^-, ν)-REACTION PROBABILITY ON ^{7}Al, ^{28}Si, AND ^{51}V NUCLEI. Bunatyan G. G.; Evseev, V. S.; Nikityuk, L. N.; Pokrovskii, V. N.; Rybakov, V. N.; Yutlandov, I. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 795-9(Apr 1970). (In Russian).

Relative probabilities of the (μ^-, ν) reaction on ^{27}Al, ^{28}Sr, and ^{51}V nuclei were measured by means of the activation method. The result is 10 ± 1, 28 ± 4, and 10 ± 1%, respectively. The obtained data are compared with the theoretical estimates, calculated using the theory of finite Fermi systems. Possible reasons for discrepancies between the experiment and the theory are discussed. (auth)

30744 A STUDY OF THE EXCITED STATES OF ^{28}Si BY MEANS OF THE ^{27}Al(p,γ)^{28}Si REACTION IN THE ENERGY RANGE E_p = 1.01 TO 2.00 MeV. Meyer, M. A.; Wolmarans, N. S.; Reitmann, D. (Atomic Energy Board, Pretoria). Nucl. Phys.; A144: 261-71(1970).

The γ-decay of 35 resonances of the reaction ^{27}Al(p,γ)^{28}Si was studied in the energy range E_p = 1.01–2.00 MeV by means of a 10 cm^3 Ge(Li) detector. The proton energies of 20 resonances as well as the energies of 11 bound levels were determined to an accuracy varying between 0.8 and 3 keV. Gamma-ray branching ratios of resonant and bound states were determined. The spins of a number of resonant and bound levels were derived from the γ-ray branching ratios. Mean lifetimes of 5 bound levels were determined from γ-ray Doppler shift measurements. (auth)

30745 PROPERTIES OF THE 3942 keV LEVEL IN ^{35}Cl AND EVIDENCE FOR A GROUND STATE ROTATIONAL BAND. Ingebretsen, F.; Broude, C.; Forster, J. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Lett.; 31B: 297-9(2 Mar 1970).

The mean nuclear lifetime of the 3942 keV $^9/_2$ level in ^{35}Cl was measured by the Doppler shift attenuation method to be 0.33 ± 0.05 ps. The decay is 6% to the 2646 keV $^7/_2^+$ level and 94% to the 1763 keV $^5/_2^+$ level and the parity is shown to be positive. This new information supports the existence of a ground state rotational band in ^{35}Cl. The in-band transition strengths are compared with Nilsson, intermediate coupling and shell model predictions. (auth)

30746 STUDY OF ^{82}Kr BY THE (α,p) REACTION. Walkiewicz, Thomas Adam. University Park, Pa.; Pennsylvania State Univ. (1969). 68p.

Thesis.

The energy levels of ^{82}Kr were determined by an investigation of the ^{79}Br(α,p)^{82}Kr reaction to solve existing discrepancies or uncertainties in the energy level schemes proposed by various authors from studies of the decay of ^{82}Br and ^{82}Rb. A 12.0-MeV alpha-particle beam was used, and the target was in the form of $CdBr_2$ enriched to 99.7 per cent in ^{79}Br. The $CdBr_2$ was evaporated onto thin carbon backings, and a very thin layer of gold was applied to both sides of the target for better heat dissipation. The proton groups from the (α,p) reaction were recorded on nuclear track plates in a broad-range magnetic spectrograph. Spectra were obtained at laboratory angles of 20, 35, 50, 90, and 145°, and energy levels at 0.0, 0.775, 1.476, 1.815, 1.956, 2.098, 2.430, 2.485, 2.551, 2.656, 2.844, 2.950, 3.015, 3.077, 3.183, 3.320, 3.360, 3.445, 3.589, 3.643, 3.681, 3.733, 3.837, and 3.930 MeV, with a standard error ranging from 5 to 10 keV, were found. The results in the region from the ground state to the 2.844-MeV level are in excellent agreement with the cumulative results for the ^{82}Kr level scheme derived from various investigations of the decay of ^{82}Br, with the addition of a new level at 2.485 MeV. A level suggested around 2.17 MeV in studies of the decay of ^{82}Rb was not observed within the limitations of the present work. Additional levels also found in ^{82}Rb studies correspond to the levels at 2.485, 2.950, and 3.183 MeV determined in the (α,p) reaction. Thus, all ^{82}Kr levels observed so far in the studies of the decay of ^{82}Br and ^{82}Rb have been confirmed by the present experiment, except for the level around 2.17 MeV. (Diss. Abstr.)

30747 PROPERTIES OF THE 5.256-MeV STATE IN ^{29}Si: EVIDENCE FOR A ROTATIONAL BAND WITH $K^\pi = 7/2^-$. Bardin, T. T.; Becker, J. A.; Fisher, T. R.; Jones, A. D. W. (Lockheed Palo Alto Research Lab., Calif.). Phys. Rev. Lett.; 24: 722-5 (6 Apr 1970).

The spin of the 5.256-MeV level in ^{29}Si was determined to be $J = 9/2$; its mean lifetime was measured to be $\tau_m = (0.95 \pm 0.15) \times 10^{-13}$ sec. The electromagnetic decay of this state is >90% via cascade radiation through the $J^\pi = 7/2^-$ state of ^{29}Si at 3.624 MeV, with $E_\gamma = 1631.3 \pm 0.5$ keV; the transition has quadrupole/dipole admixture $\delta = -0.49 \pm 0.07$. This multipole mixing together with the measured lifetime fix parity $\pi = -1$ for this state. (auth)

30748 DEEXCITATION VIA UNBOUND STATES IN THE RADIATIVE CAPTURE OF 14 MeV NEUTRONS. Cvelbar, F.; Hudoklin, A.; Mihailovic, M. V.; Potokar, M. (Josef Stefan Inst., Ljubljana, Yugoslavia. Univ. of Ljubljana, Yugoslavia). Fizika (Zagreb); 2: 41-3(1 Jan 1970).

Cross sections for 14-MeV neutron capture obtained by activation methods were compared with integrated cross sections obtained from measurements of prompt γ spectra were compared in order to establish deexcitation modes. It was found that for light and intermediate nuclei the compound states deexcite almost completely to the bound states of the final nuclei. For some heavier nuclei however, the deexcitation through unbound states is several times more intense than deexcitation directly to bound states. (J.W.R.)

30749 PIONIC ATOM 3d–2p LINE SHIFT AND WIDTH FOR ^{40}Ca AND ^{44}Ca AND THE NEUTRON DISTRIBUTION. Kunselman, Raymond (Univ. of Wyoming, Laramie); Grin, Georges-Andre. Phys. Rev. Lett.; 24: 838-40(13 Apr 1970).

^{44}Ca was found to show both a smaller shift and width than ^{40}Ca for the 3d–2p pionic-atom x-ray transition. From this measurement and an optical-model analysis, it can be deduced that the neutron distribution at the surface of the ^{44}Ca nucleus extends significantly beyond the proton distribution. (auth)

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Refer also to abstracts 29308, 29445, 29515, 29530, 29533, 29545, 29550, 29601, 30438, 30684, 30685, 30694, 30702, 30720, 30722, 30734, 30748, 30894, 30903, 30938, and 30958.

30750 (ANL-Trans–823) LEVELS OF ^{146}Nd EXCITED IN THE (n,γ)-REACTION. Berzin, Ya. Ya.; Krumniya, A. E.; Prozhef'ev, N. T. Translated for Argonne National Lab., Ill., from a Russian preprint. 7p. Dep. CFSTI.

The spectrum of conversion electrons emitted during the capture of thermal neutrons by neodymium-145 is investigated in order to refine and supplement the level scheme of neodymium-146. The spectrum of conversion electrons and gamma rays from these reactions is shown. (J.F.P.)

30751 (ANL-Trans–824) LEVELS OF ^{144}Nd EXCITED DURING THERMAL NEUTRON CAPTURE. Berzin, Ya. Ya.; Kruminya A. E.; Prokof'ev, P. T. Translated for Argonne National Lab., Ill., from a Russian preprint. 11p. Dep. CFSTI.

Measurements were made of the conversion electron spectra emitted during the thermal neutron capture by neodymium-143 in order to determine more accurately the multipole order of transitions to complete the level scheme and establish more accurately their energies. This level scheme is shown. (J.F.P.)

30752 (BNL-tr-347) NEW NEUTRON-DEFICIENT ISOTOPES OF ^{169}Hf, ^{167}Hf, ^{166}Hf, AND ^{166}Lu. DECAY SCHEME OF ^{169}Hf. Arl't, R.; Malek, Z.; Muziol, G.; Pfrepper, G.; Shtrusnyi, Kh. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Izv. Akad. Nauk SSSR; 33: 1232-43(Aug 1969). 17p. Dep. CFSTI.

This item was previously abstracted from the original language and appeared in NSA as 24: 8913.

30753 (KFK–1116) SEARCH OF PARITY MIXING IN ^{181}Ta BY MEASUREMENT OF THE CIRCULAR POLARIZATION OF γ RAYS. Bock, P.; Jenschke, B. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Dec 1969. 8p. Dep. CFSTI (U. S. Sales Only).

The circular polarization of the 482 keV-γ-radiation of ^{181}Ta was measured. The result is $P = -(6.0 \pm 2.5)10^{-6}$. This number is corrected for instrumental asymmetries and bremsstrahlung. (auth)

30754 (KFK-tr-309) ALPHA DECAY OF HEAVY NUCLEI. Muzychika, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, Ger.), from report JINR–P7-4435. 14p. (In German). Dep. CFSTI (U. S. Sales Only).

This item was previously abstracted from the original language and appeared in NSA as 23: 32930.

30755 (LUNP–7003) ANGULAR DISTRIBUTIONS IN HIGH-ENERGY PHOTOFISSION OF GOLD AND LEAD. Kroon, Ingvar; Forkman, Bengt (Lund Inst. of Tech. (Sweden). Dept. of Nuclear Physics. Lund Univ. (Sweden). Dept. of Physics). Feb 1970. 20p. Dep. CFSTI (U. S. Sales Only).

The angular distributions of fragments in photofission of gold and lead were measured in the bremsstrahlung energy range 350-1000 MeV. Glass detectors were used for measurements; angular distributions were nearly isotropic in the laboratory system with a small but significant forward peaking. This anisotropy is supposed to be an effect of nuclear motion. (SW) (Sweden)

30756 (LUNP–7004) HIGH ENERGY PHOTON INDUCED SPALLATION REACTIONS IN ^{127}I. Jonsson, G. G.; Persson, B. (Lund Univ. (Sweden)). Mar 1970. 41p. Dep. CFSTI (U. S. Sales Only).

The yields for 28 different ^{127}I(γ,yp xn) reactions were measured by activation analysis from their thresholds up to 1 GeV. The mean cross sections in the energy region 250-900 MeV were determined. Photon and particle induced spallation cross section distributions were compared using a five parameter formula given by Rudstam and the significance of the different parameters is discussed. The mean total high energy cross section was compared to the total free-nucleon photo-pion cross section. Some calculations on the basis of the cascade-evaporation model were carried out. Finally the empirical cross section formula was used to estimate some photon induced spallation cross sections. (auth) (SW)

30757 (LUNP–7005) HIGH ENERGY PHOTOFISSION CROSS SECTIONS OF URANIUM AND THORIUM. Methasiri, T.; Johansson, S. A. E. (Lund Univ. (Sweden). Dept. of Nuclear Physics). Apr 1970. 18p. Dep. CFSTI (U. S. Sales Only).

The photofission cross sections of uranium and thorium were measured in the bremsstrahlung energy range 200 to 900 MeV. A glass detector was used to detect the fission fragments. Fission cross sections were obtained from the integrated cross section using Penfold and Leiss's method. It was found that the photofission cross sections of both uranium and thorium show resonance peaks at a photon energy of 350 MeV, with peak values of 80 and 60 mb respectively. It is suggested that in a high energy fission, the fission mechanism can, at least in part, be due to photo meson production processes. (auth) (SW)

30758 (N-70-13431) $\alpha-\gamma$ ANGULAR CORRELATIONS IN THE REACTION ^{120}Sn($\alpha,\alpha'\gamma$) FOR THE 1.18-MeV LEVEL. Leonard, Regis F.; Stewart, William M.; Baron, Norton (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec 1969. 20p. (NASA-TN-D-5569). CFSTI.

The angular correlation between inelastically scattered 42-MeV

alpha particles and gamma rays emitted in the subsequent nuclear decay was studied for the 1.18 MeV (2+) state of tin-120. The symmetry angle and the magnitude of the anisotropy of the gamma distribution were measured for alpha-scattering angles between 15 and 60°. The results are compared with the distorted-wave predictions and with the adiabatic model. The observed symmetry angles in no way aid in removing the optical model ambiguities that exist for 42-MeV alpha particle scattering on tin. (auth) (STAR)

30759 (NP-18213) BETA-GAMMA CIRCULAR POLARIZATION CORRELATION MEASUREMENTS ON SOME ODD-MASS NUCLEI. Van Rooijen, Jan Johan (Amsterdam Univ. (Netherlands)). 1970. 103p. Dep. CFSTI (U. S. Sales Only).

Thesis.

The $\beta-\gamma$ circular polarization correlation measurements in ^{203}Hg, ^{199}Au, and ^{141}Ce are studied. Theoretical aspects of first-order forbidden β decay, Compton scattering of polarized photons, polarization analyzers, and detectors electronics and corrections are considered. (J.F.P.)

30760 (STI/PUB-176) DELAYED FISSION NEUTRONS. Panel Proceedings Series. Proceeding of a Panel Held in Vienna, 24-27 April 1967. (International Atomic Energy Agency, Vienna (Austria)). Jun 1968. 258p. (In several languages). (CONF-670424). IAEA $5.00.

Fourteen articles are included; an abstract was prepared for each. (P.C.H.)

For abstracts of individual papers see: 29173, 30767–30776, 30874, 31044, and 31045.

30761 (STI/PUB-234) PHYSICS AND CHEMISTRY OF FISSION. Proceedings Series. Proceedings of the Second IAEA Symposium Held in Vienna, 28 July–1 August 1969. (International Atomic Energy Agency, Vienna (Austria)). Dec 1969. 996p. (In several languages). (CONF-690708). IAEA $25.00.

Separate abstracts were prepared for 49 of the 55 papers presented. The remaining 6 papers have previously appeared in NSA. (J.W.R.)

For abstracts of individual papers see: 29221, 30777–30807, and 30894–30910.

30762 (UCRL-19405) PROSPECTS FOR SUPER HEAVY NUCLEI. Swiatecki, W. J. (California Univ., Berkeley. Lawrence Radiation Lab.). 25 Jul 1969. Contract W-7405-eng-48. 40p. (CONF-690707-4). Dep. CFSTI.

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany.

The use of heavy ions to form super-heavy elements is discussed. A macroscopic approach to heavy-ion and fission physics is promoted as the appropriate starting point for the formation. The two principal difficulties emphasized are making the neutron to proton ratio approximately 184/110 and making the reaction gentle enough to avoid shattering the extremely brittle super-heavy nucleus. (L.W.A.)

30763 (UCRL-19533) WEAK INTERACTION STUDIES BY NUCLEAR ORIENTATION. Brewer, William D. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec 1969. Contract W-7405-eng-48. 210p. Dep. CFSTI.

Thesis.

The technique of low temperature nuclear orientation was applied to two problems involving weak nuclear decays. Nuclei of ^{119}Sb were polarized in an iron lattice and the angular distribution of inner bremsstrahlung photons emitted during the electron capture decay was observed. The distribution fit the correlation function $W(\theta) = 1 + A_1G_1P_1(\cos\theta)$ and the asymmetry coefficient had the theoretical value of +1.0 near the spectrum endpoint. However, some energy dependence of A_1 was observed, in contrast to theoretical expectations. Possible origins of the energy dependence are discussed. Nuclear orientation was also carried out with three isotopes which undergo 1st forbidden beta decays: ^{186}Re, ^{188}Re, and ^{194}Ir. The source nuclei were polarized in iron lattices and the angular distributions of both beta particles and gamma rays were observed. Lithium-drifted germanium counters were used to detect the beta particles. The beta particle angular distribution coefficients A_1 and A_2 are reported as functions of energy. The results are in general agreement with those of previous workers, although the experimental errors have been considerably reduced. The attenuation of the gamma ray anisotropies gives a measure of the relative size of the $\int B_{ij}$ matrix element in the preceding $1^- \rightarrow 2^+$ beta decays and values for this attenuation are reported. The $\int B_{ij}$ matrix element was found to make a finite contribution in the decays of the two Re isotopes, but to be zero in the ^{194}Ir decay. The combined data may be used to determine the nuclear matrix elements entering the decays and to test the conserved vector current hypothesis of weak interactions. (auth)

30764 (UCRL-50810) FOUR-PARAMETER MEASUREMENTS OF DELAYED GAMMA RAYS FROM SPONTANEOUS FISSION OF ^{252}Cf. Guy, Frank W. (California Univ., Livermore. Lawrence Radiation Lab.). 2 Feb 1970. 97p. Dep. CFSTI.

Thesis.

In this experiment, the energies, half-lives and intensities of 144 gamma-ray transitions following ^{252}Cf fission were measured, and the masses of the emitting fragments were determined. The experiment covered a time range of 5 to 2000 nsec and a gamma-ray energy range of 90 to 2860 keV. A ^{252}Cf fission source on a thin foil was placed between two silicon fission-fragment detectors; a Ge(Li) gamma-ray detector was exposed to one fragment detector. For each triple-coincidence event, the three detector pulse heights and the electronically measured delay time were recorded. Fragment masses were calculated from fission-fragment-detector pulse heights. Most masses produced delayed gamma rays; however, the intensity varied greatly from mass to mass. The total delayed spectrum showed a low-energy component peaking at 100 to 150 keV and a high-energy component consisting of a few transitions in the 1300-keV range. The latter was produced by masses with A = 134 to 137 and accounted for most of the delayed gamma-ray energy after 50 nsec. An analysis of the data showed that the 144 resolved lines accounted for 80% or more of the gamma-ray energy emitted from 100 to 2000 nsec. The half-lives of most of the transitions are consistent with E1 or E2 transition rates; there is little evidence of rotational structure. (auth)

30765 (UJV-2347-F) RADIOACTIVE DECAY OF $^{183+183m}$Os. Plajner, Z.; Brabec, V.; Maly, L.; Venos, D. (Ceskoslovenska Akademie Ved, Rez., Ustav Jaderneho Vyzkumu). Mar 1970. 15p. Dep. CFSTI (U. S. Sales Only).

The decay of $^{183+183m}$Os was investigated with a magnetic beta ray spectrometer, permanent magnet spectrograph, Ge(Li) detectors and $\gamma-\gamma$ coincidence techniques. The energies and gamma-ray intensities of 50 transitions in ^{183}Re following the decays of $^{183+183m}$Os were determined. Internal conversion measurements have yielded the multipole character of nine strongest transitions. The ^{183}Os proposed decay scheme was tested by a two-parameter $\gamma-\gamma$ coincidence experiment while the ^{183m}Os decay scheme is only proposed on the energy sums and intensity considerations. (auth)

30766 (UUIP-672) LIFETIMES OF EXCITED STATES IN ^{119}Sb. Vaelivaara, K. G.; Marelius, A.; Kozyczkowski, J. (Uppsala Univ. (Sweden). Inst. of Physics). Nov 1969. 9p. Dep. CFSTI (U. S. Sales Only).

The lifetimes of three excited states in ^{119}Sb were measured by delayed coincidence technique. The results are: the 270.3 keV level: $T_{\frac{1}{2}} = 10 \pm 9$ ps; the 1212.6 keV level: $T_{\frac{1}{2}} = 46 \pm 8$ ps; the 1365.8 keV level: $T_{\frac{1}{2}} \leq 330$ ps. (auth) (SW)

30767 WHICH FISSION PRODUCT ISOTOPES ARE DELAYED NEUTRON PRECURSORS? Tomlinson, L. (Atomic Energy Research Establishment, Harwell, Eng.). pp 61-71 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI-PUB-176; CONF-670424.

Since the first detailed predictions of delayed neutron percursors were made some 7 to 10 years ago, new theoretical and experimental data have become available. Using the latest data, new predictions are made of delayed neutron precursors in fission together with their P_n values and half-lives. The predictions are limited to the thermal neutron fission of ^{235}U but the method could be applied to any fissile nuclide for which fission yields can be calculated. One notable difference between the present predictions and those given earlier is the far larger range of elements included in the light peak region. Elements such as strontium, yttrium and niobium should all have isotopes with detectable neutron emission. The predictions are compared with the presently known delayed neutron precursors and areas for future work are defined. Finally, physical and chemical techniques capable of extending our knowledge in this field are briefly reviewed. (auth)

30768 MEASUREMENT OF DELAYED NEUTRON MASS- AND TIME-DEPENDENCE BY AN ON-LINE MASS SEPARATOR OF THE COHEN TYPE. Roecki, E.; Eidens, J.; Armbruster, P. (Kernforschungsanlage, Juelich, Ger.). pp 85-102 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI-PUB-176; CONF-670424.

A helium-filled or Cohen type mass separator for fission products has been installed at the FRJ-2 reactor. A source of ^{235}U is exposed to a thermal neutron flux of 10^{14} n cm^{-2} sec^{-1} and yields

2.5×10^{12} fission events per second. The fission products coming from the beam hole collimator pass through a helium-filled focusing magnetic deflection system, travelling on a constant radius path of radius ρ under field B and are separated such that the $B\rho$-value is proportional to $A^{\frac{1}{2}}$. For a helium pressure of 7 mmHg an optimum resolving power of $A/\Delta A = 16$ has been obtained. The separation time (~1 μsec) is the flight time in the separator. For high yield fission products, beams of 10^4 n cm^{-2} sec^{-1} have been measured in the focus of the separator. To determine absolute yields of delayed neutron emitters an activity build-up technique has been used, with a neutron detection system at the focus of the separator. For activity decay measurements the detection system is situated 25 cm above the focus. A discontinuously operating transport tape collects the fission products and transfers the irradiated target rapidly to the detector position. The delayed neutron detection system used is an assembly of ^{3}He-counters embedded in polyethylene and a β-proportional counter; they operate in coincidence. With optimized coincidence resolution time the signal-to-background ratio is increased by up to two orders of magnitude. The n-β-coincidence method is discussed. Delayed neutron activities have been measured in the mass region of light fission products. Their variation both with the mass of the fission products and with time has been investigated. The measurements are compared with published data. Evidence is given for neutron activities with half-lives smaller than a few seconds and masses larger than 90. (auth)

30769 A PROGRAMME FOR A SYSTEMATIC EXPERIMENTAL STUDY OF DELAYED NEUTRON EMISSION IN FISSION. Amiel, S.; Gilat, J.; Notea, A.; Yellin, E. (Soreq Nuclear Research Centre, Yavne, Israel). pp 115-45 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI/PUB-176; CONF-670424.

The program of the Soreq-On-Line Isotope Separator (SOLIS) aimed at the study of very short-lived nuclides produced in thermal and 14-MeV neutron-induced fission is outlined. The use of appropriate chemical separation methods in conjunction with the isotopic separation facilitates the observation, at steady state conditions, of individual rapidly decaying nuclides. This system will be used for a systematic investigation of delayed neutron emission, viz. identification and characterization of precursors followed by a detailed study of nuclear structure and independent yields. At present, techniques for the rapid separation of rare gas and halogen fission products, suitable for on-line isotopic separation, are being developed. For rare gas studies, a uranium–barium stearate emanation source swept by a stream of nitrogen gas is being used. The decontamination factor with respect to halogen is $\approx 10^5$, and higher for other activities. Separation time of ~2 seconds is routine. With this system (without isotopic separation), it was possible to establish delayed neutron emission from both ^{93}Kr($T_{\frac{1}{2}}$ = 1.19 to 0.05 sec, P_n = 3.9%) and ^{93}Rb($T_{\frac{1}{2}}$ = 5.60 ± 0.05 sec, P_n = 2.6%). The half-life of ^{94}Kr is estimated as 0.4 ± 0.1 sec. For bromine and iodine, selective recoil labelling is used (for extraction of independently produced species while the same nuclides produced by beta decay are discriminated against) followed by fast gas chromatography. Using empirical P_n-values and fission yields for 14 known precursors, good fits to experimental total delayed neutron yields of groups 1-4 were obtained for a series of fission reactions. Systematic deviations indicate unidentified precursors. The inconsistencies between expected and reported results on delayed neutron yield variations with the energy of the fission-inducing neutrons are being checked by high resolution γ-ray spectrometry in conjunction with neutron counting, with the aim of determining these relations with neutrons of various energies (thermal, fission and 14 MeV). A technique for obtaining data on the masses and half-lives of delayed neutron precursors, based on selective collection, through a bias potential, of recoils from neutron emission, is being studied. The energies of delayed neutrons from gross and separated elements produced in fission are being studied with an improved ^{3}He spectrometer and time-of-flight techniques. (auth)

30770 RECENT WORK ON DELAYED FISSION NEUTRONS AT THE UNIVERSITY OF MAINZ. Herrmann, G. (Univ., Mainz). pp 147-66 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI/PUB-176; CONF-670424.

The Mainz group is investigating the following aspects of delayed neutron emission in low-energy fission: Delayed neutron yields reported for various fission reactions are compared with calculated cumulative fission yields of known and predicted precursor nuclides to show whether the delayed neutron yields can be explained by known precursors or whether improvements result if as yet unknown precursors are assumed to contribute; Delayed neutron yields of bromine and iodine precursors are measured in several fission reactions, as are the total contributions of non-halogen elements to the four longest periods; Delayed neutron precursors among the nuclides of the alkalies and alkaline earths; Absolute delayed neutron yields are determined in fission of ^{232}Th and ^{238}U by 14-MeV neutrons by comparison of neutron and fission rates with fission of ^{235}U by thermal neutrons as a reference reaction. (auth)

30771 EMISSION OF DELAYED NEUTRONS IN NUCLEAR REACTIONS INDUCED BY HIGH ENERGY PARTICLES. Gauvin, H. (Faculte des Sciences de Paris, Orsay, France). pp 167-82 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968). (In French).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI/PUB-176; CONF-670424.

A review of recent results on delayed neutrons from nuclear reactions at high energy is presented. A survey of new precursors, identified or expected in light nuclei, and obtained by spallation and fragmentation reactions, is followed by a more careful examination of the fission reactions. At medium and high energies, two problems were considered: characteristics of the delayed neutron emission and identification of new precursors. At present, the unambiguous characterization of short-lived precursors represents one of the most important problems. Using an on-line spectrometer, isotopes of rubidium and cesium, produced by fission in a uranium target bombarded by a 150-MeV proton beam, were separated and analyzed. Systematic research resulted in the identification of the following precursors: isotopes 93, 94, 95, 96 of rubidium, and 142, 143 of cesium. The results are discussed. The general characteristics of emission of delayed neutrons accompanying the ^{238}U fission by protons at 150 MeV, 1 and 2.8 GeV energies, and ^{232}Th and ^{209}Bi fission at 150 MeV are examined. The following features were considered: the total emission cross section, the relative yields in fission, groups and their relative abundances. The abundances of delayed neutrons are compared to the calculated fission yields of the identified or expected precursors for the reaction ^{238}U + p (150 MeV) and for thermal fission of ^{235}U. (auth)

30772 DELAYED NEUTRONS FROM URANIUM ISOTOPES, ^{232}Th, AND ^{239}Pu. Maksyutenko, B. P. (Inst. for Physics and Power, Obninsk, USSR). pp 191-202 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968). (In Russian).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI/PUB-176; CONF-670424.

Relative delayed neutron yields were measured for the fission fractions after the fission of different uranium isotopes, thorium-232 and plutonium-239. The energy of the bombarding neutrons was varied over the range 5 to 8 MeV. The experimental data for five groups of delayed neutrons were obtained and are presented as the ratio of the i-th group of delayed neutrons to the first group (55 sec). The results are discussed from the point of mass distribution of fission fractions and precursors. (auth)

30773 DELAYED NEUTRONS FROM NUCLEAR FISSION BY NEUTRONS WITH ENERGIES OF 15 TO 21 MeV. Maksyutenko, B. P.; Ramazanov, R.; Tarasko, M. Z. (Inst. for Physics and Power, Obninsk, USSR). pp 203-7 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI/PUB-176; CONF-670424.

Relative delayed neutron yields were measured for the fission of uranium isotopes in the fissioning range of 15 to 21 MeV. The results of the fission of uranium-235 and -238 were compared for this energy range and the correspondence of the uranium-235 curve at this energy with that for uranium-233 in the energy range 5 to 8 MeV is discussed. The yields were assessed in the case of processes (n,3nf) and (n,nf), and it was found that the first reaction is the more dependent on the energy of the incident neutrons producing the fission. (auth)

30774 WORK IN GREECE ON DELAYED NEUTRONS. Chrysochoides, N. G.; Nicolitsas, A. J.; Papadopoulos, N. N.; Zikides, C. C.; Mitsonias, C. A. (Democritus Nuclear Research Centre, Athens). pp 213-27 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI/PUB-176; CONF-670424.

At present, two programs on delayed neutron research are in progress in Greece. In an experiment at the 1 MW Democritus reactor, the energy of the delayed neutrons from ^{235}U fission is measured by the time-of-flight technique and β-n-coincidence using a special fast system for irradiation of the sample. The beta particle preceding the emission of the delayed neutron is used as a start pulse while the delayed neutron provides a stop

signal. A maximum flight time of approximately 100 nsec is allowed over a flight distance of approximately 30 cm (longer flight paths could be used for better energy resolution, but this would decrease the efficiency of detecting the delayed neutron). To avoid false measurements due to other beta particles which do not correspond to delayed neutrons, an anti-coincidence system is used to cancel the measurement whenever two beta particles come in a time interval shorter than 100 nsec. Coincidences due to delayed neutrons are relatively rare in comparison with chance coincidences or $\beta-\gamma$-coincidence. The spectrum obtained in a first run of measurements is discussed. An attempt will be made to measure the spectrum of each individual group by varying the irradiation time and the measuring time. Various irradiation, transfer and measuring times can be obtained with the existing experimental set-up. A minimum transfer time of 300 msec can be achieved. Very thin foils (a few mg/cm^2) are used to minimize the beta-particle absorption in the sample. In a second experiment, measurements to determine the relative abundances and periods of the delayed neutrons for various fissile materials are now under way. The arrangement for delayed neutron group measurement allows the sample to be transferred in a minimum time of approximately 800 msec. Accordingly, delayed neutrons of quite short half-lives can be detected. The experimental facility permits very accurate repetition of each cycle of measurement which results in good statistical accuracy. In earlier work, measurements of delayed neutron precursor relative abundance for ^{235}U fission by thermal neutrons have been performed using the radiochemically known half-lives of iodine and bromine. (auth)

30775 BANDSAW: A PROPOSAL FOR REMEASURING DELAYED NEUTRON ENERGIES, YIELDS, AND HALF-LIVES IN AFSR-TYPE REACTORS. Brunson, G. S.; Huber, R. J. (Argonne National Lab., Idaho Falls, Idaho). pp 229-36 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI/PUB-176; CONF-670424.

Traditionally, delayed neutrons have been measured by means of a "rabbit" experiment in which a sample of the fissionable isotope is irradiated in a neutron flux and rapidly transferred to a neutron counting geometry. Here we consider attacking the problem by means of a "long foil" sample in the form of an endless tape passing bandsaw fashion through the "glory hole" of a small reactor such as the Argonne Fast Source Reactor. This new approach in a field that has not really been examined since the Los Alamos work was completed nearly ten years ago, has a number of advantages: It permits delayed neutron counting under steady-state conditions; there is a chance of observing very short-lived delayed neutrons that might have been overlooked in a rabbit experiment; and it provides by a very wide margin the best look yet at delayed neutron energies. An endless uranium bearing sample tape runs at a constant speed through the glory hole of AFSR and then through a neutron counting geometry located as closely as possible to the reactor core. At various tape speeds the various delayed neutron groups attain their maximum emphasis. The design of a suitable uranium bearing tape and the best detector arrangement using a ^{3}He-filled proportional counter operating into a multichannel pulse-height analyzer are discussed in detail. Such a system would enable the calculation of relative yields, and the data can be re-analyzed for delayed neutron energies. The same equipment used with a gamma spectrometer can be used to analyze the energies of early fission fragment decay gammas. This is of particular value in the calculation of delayed photo-neutron production in reactors containing beryllium or heavy water. Obviously, the overwhelming quantity of data produced by Bandsaw does offer considerable advantage in determining yields and decay constants. Nevertheless, the outstanding advantage of the method is that it permits steady-state measurement of delayed neutron spectra. The most suitable sites for performing the experiment are reactors of the AFSR-type. However, ^{238}U might be investigated in almost any university reactor thermal column if cadmium tubing is used to define the region of irradiation. (auth)

30776 SUMMARY OF EXPERIMENTAL DATA ON DELAYED NEUTRON PRECURSORS BASED ON REPORTS TO THIS PANEL. del Marmol, P. (comp.) (CEN, Mol, Belg.). pp 242-7 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI/PUB-176; CONF-670424.

The experimental data concerning charge, mass, and half-life attributed to and the relative contributions of individual delayed neutron precursors presented to the IAEA Panel Meeting on Delayed Neutrons are summarized. (J.W.R.)

30777 TERNARY FISSION OF ^{240}Pu AND ^{242}Pu. Muga, M. L. (Univ. of Florida, Gainesville. Brookhaven National Lab., Upton, N. Y.); Rice, C. R. pp 107-14 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Using the facilities of the Brookhaven Graphite Research Reactor (BGRR) continuation of ternary fission investigations was made by extending previous experiments to cover the fissioning systems ^{240}Pu* and ^{242}Pu*. The experiment involves fission fragment detection and energy analysis by three solid-state detectors positioned 120° apart in a plane about a fission source. The output pulse from each detector is digitally analysed and recorded event by event whenever a parallel triple coincidence circuit is satisfied. Earlier data, indicating clear distinctions in the ternary fission of these two nuclei, have been confirmed with much greater statistical confidence. The frequency of occurrence is approximately one per 10^6 binary-fission events, the total-kinetic-energy release is slightly less than that for binary fission, about 150 MeV and 165 MeV for the systems ^{240}Pu* and ^{242}Pu*, respectively. In general, it was found that the characteristics of this fissioning pair (^{240}Pu* and ^{242}Pu*) are in many respects remarkably similar to the features observed for the comparable fissioning pair, ^{234}U* and ^{236}U*. The differences between members in each pair closely parallel each other; this is especially true when the individual fragment-kinetic-energy spectra and the fragment mass distributions are compared. The distinction between the individual fragment-kinetic-energy spectra clearly rules out the possibility of Coulomb scattering, accidental, or spurious events as probable causes of the triple-coincidence data. Evidence of light-mass fragment production in or near the range 30–40 amu and 50–60 amu is also observed. The fission type ratio (I/II) defined in previous work was evaluated as 0.6 ± 0.1 for ^{240}Pu* and 2.7 ± 0.8 for ^{242}Pu* further emphasizing the distinction between the two fissioning systems and reconfirming the extensive role which underlying shell-structure effects exhibit with respect to the tripartite mode of fission. (auth)

30778 CORRELATED EMISSION OF LIGHT NUCLEI AND NEUTRONS IN ^{235}U AND ^{252}Cf FISSION. Blocki, J.; Chwaszczewska, J.; Dakowski, M.; Krogulski, T.; Piasecki, E.; Piekarz, H.; Tys, J. (Inst. of Nuclear Research, Warsaw). pp 115-18 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The yields of protons and tritons in relation to the α-particle yield were measured in coincidence with the prompt fission neutrons from spontaneous fission of ^{252}Cf and thermal neutron fission of ^{235}U. A conclusion on the relation between the average number of prompt neutrons and the type of charged particles involved was made by making assumptions on the angular and energy distributions of the neutrons. (auth)

30779 ALPHA PARTICLES EMITTED DURING THE TRIPARTITION OF ^{235}U BY THERMAL NEUTRONS. Carles, C. (Faculte des Sciences, Bordeaux); Asghar, M.; Doan, T. P.; Chastel, R.; Signarbieux, C. pp 119-32 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969). (In French).

From 2nd Conference on Physics and Chemistry of Fission, Vienna. Austria. See STI/PUB-234; CONF-690708.

Using the charged nuclear emulsions method, the emission of alpha particles during the tripartition of ^{235}U by thermal neutrons was studied. About 3000 events were analyzed. The main aim of the experiment was to obtain a very high precision (±2°) in the measurement of the angle between the alpha particle and the light fission fragment. However, the accurate measurement of the range of the two fragments (±1 μm) enables the authors to find the ratio of the fragment masses with an accuracy of about 10%. It was, thereby, possible to study the variation of a certain number of parameters as a function of this ratio. The following main results were obtained: 1. The most probable value of the energy of the alpha particle seems to be independent of the ratio between the fission fragment masses. 2. The most probable value of the angle between the alpha particle and the light fission fragment grows with the ratio of the fission fragment masses. This curve shows discontinuities corresponding to fragments having a magic number of nucleons. 3. The most probable value of the kinetic energy of the alpha particle varies very strongly with the final emission angle of this particle with respect to the light fragment and shows a minimum in the neighbourhood of the most probable value (~83°). 4. The angular distribution of the alpha particles with respect to the light particle increases with the kinetic energy of these particles. These results are compared with existing data on other

fissile nuclei and an attempt is made to interpret them phenomenologically. (auth)

30780 STATISTICAL TESTS FOR THE DETECTION OF INTERMEDIATE STRUCTURES IN THE FISSION CROSS-SECTIONS OF ^{235}U AND ^{239}Pu. Perez, P. B. (Oak Ridge National Lab., Tenn.); de Saussure, G.; Moore, M. N. pp 283-305 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The existence of intermediate structures in the neutron-induced fission cross sections of ^{235}U and ^{239}Pu was pointed out in 1957 by Egelstaff. An interpretation, recently proposed by Cao et al., and Blons et al., was based on the Strutinsky calculations of the deformation energies of the compound nucleus when shell effects are included in the liquid-drop model. The theoretical interpretation in terms of current reaction theories has been given by Weigmann and Lynn. The purpose of this paper is to develop and evaluate various statistical tests intended for the detection and interpretation of these narrow intermediate fission structures. A fission cross section was computed in the interval 0-5 keV using randomly generated parameters with distributions chosen to mock up the ^{235}U nucleus. The $J^{\pi} = 4^-$ state fission width was "modulated" in the manner suggested by Weigmann's work. Auto-correlation and cumulative average tests were done on these mock-up cross sections to determine if the correct average spacing of the shape isomer levels could be obtained by such tests. It is shown that the usual correlation tests tend to overestimate the spacing between structures. A proposed technique is based on the direct analysis of the averaged cross section which affords a method of correcting for peaks of the intermediate structure below the detectability limit of the usual tests. The techniques developed on the basis of the mock-up cross sections were used to analyze the fission cross sections of ^{235}U and ^{239}Pu. Average spacings of 227 and 312 eV were found for those two nuclei, respectively. These values are somewhat lower than the ones reported by Cao and Blons, which were based only on the auto-correlation analysis. The energy of the second minimum in the fission barrier was found to be 3.1 MeV for ^{235}U and 2.9 for ^{239}Pu. Both values are in close agreement with the values of 3 MeV predicted by Strutinsky. (auth)

30781 INTERMEDIATE STRUCTURE IN THE FISSION CROSS-SECTIONS OF NEPTUNIUM-237 AND PLUTONIUM-239. Paya, D.; Blons, J.; Derrien, H.; Michaudon, A. (CEN, Saclay, France). pp 307-20 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969). (In French).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The total (σ_T) and fission (σ_f) cross sections of ^{237}Np and ^{239}Pu for resonance neutrons were measured by the time-of-flight method. The cross section σ_f of ^{237}Np consists of resonance groups of certain discrete energies whose mean spacing is about hundred times that of the resonances observed in σ_T. The analysis of the resonances forming the first "group" of 40 eV shows that the intermediate structure in σ_f of ^{237}Np is due to the coupling of the compound-nucleus states (corresponding to the resonances of σ_T) to the fission exit channels, which is strongest at certain discrete energies where the resonance groups appear. This phenomenon may be interpreted as one of the consequences of the double-humped fission barrier resulting from Strutinsky's calculations. Compound-nucleus states (termed class-II states by Lynn) may exist between the two humps; these states should be responsible for the increase of the coupling to the fission exit channels of certain energies. A careful study of σ_f of ^{237}Np also shows other small resonance groups suggesting the existence of a type of coupling which, on the average, should be weaker than the preceding one, which essentially corresponds to the large groups. One can thus be led to the assumption of two types of barrier which could correspond to the two spin states 2^+ and 3^+. A finer analysis of σ_f in the 40 eV group shows that there exists a large resonance below the narrow resonances, characteristic of the weak coupling in which the first hump of the fission barrier (between the two minima) is higher than the second one. A study of the autocorrelations in σ_f of ^{239}Pu suggests the existence of an intermediate structure whose mean spacing might be about 450 eV. An analysis of the resonances up to 660 eV shows that the mean fission width of the 1^+ resonances decreases very rapidly at about 600 eV. Therefore an intermediate structure due to the 1^+ fission exit channel (or channels) exists. Nevertheless the probable presence of autocorrelations in σ_T and the variations of the local density function as a function of the energy do not exclude the possible existence of an intermediate structure due to the entrance channel. (auth)

30782 EFFECTIVE K QUANTUM NUMBERS IN FISSION OF ORIENTED ^{235}U. Dabbs, J. W. T. (Oak Ridge National Lab., Tenn.); Eggerman, C.; Cauvin, B.; Michaudon, A.; Sanche, M. pp 321-36 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The angular anisotropy of fission fragments produced in neutron-induced fission aligned ^{235}U nuclei was measured for neutron energies between 0.3 eV and 175 eV, using time-of-flight techniques at the pulsed 45-MeV electron linear accelerator. The low-temperature nuclear-alignment apparatus used was a modified version of the apparatus described at the Salzburg conference; and gave an average temperature of 0.61 K for the four $UO_2Rb(NO_3)_3$ single crystal samples during a measurement period of approximately 220 h. The flight path was 5 m and the electron pulse length was 100 ns. Multilevel fits to the observed 0 and 90° fission cross sections were made using the Adler and Adler formalism with the aid of a program developed by G. de Saussure. The most striking result obtained in the analysis of some 16 of 100 levels or groups of levels is a strong correlation between small fission width and an effective value of $K \cong J$. All 5 resonances in the group of 16 for which results are final, for which $K \cong J$ is deduced, have exceptionally small widths. This result suggests that the small widths are associated with a large rotational energy and consequent diminution in available deformation energy, so that these 5 resonances are effectively sub-threshold resonances; such a suggestion is quite in accord with the ideas of Bohr. The preponderance of other resonances so far analyzed have effective K values of 1 or 2. An analysis of all resolvable resonances is presented. (auth)

30783 ANALYSIS OF RESONANCES OBSERVED IN (d,pf)-REACTIONS. Back, B. B.; Bondorf, J. P.; Otroshenko, G. A.; Pedersen, J.; Rasmussen, B. (Univ. of Copenhagen). pp 351-62 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Fission cross sections in the (d,pf)-reaction on ^{233,235}U and ^{239,241}Pu were measured with 37 keV resolution. A model is proposed for describing the observed pronounced resonance structure in the excitation function. The cross section is assumed to be $\sigma_{d,pf} = \Sigma\sigma_{d,p}\Gamma_f/(\Gamma_f + \Gamma_\gamma)$. For the analysis of data, $\sigma_{d,p}$ is calculated in the DWB-approximation using the Nilsson-model single-particle states. The fission penetrability is calculated by numerical integration for a double-humped fission barrier. Thus, it is assumed that the observed resonances in the (d,pf)-reaction can be interpreted as quasi-bound states in the second minimum of the fission barrier. (auth)

30784 FISSION INDUCED BY THE ^{240}Pu(p,p'f) REACTION. Britt, H. C.; Burnett, S. C.; Cramer, J. D. (Los Alamos Scientific Lab., N. Mex.). pp 375-85 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

It was suggested that the threshold peak at ~5-MeV excitation energy observed in the fission probability for the ^{239}Pu(d,pf) reaction may be due to a resonance in the fission penetrability through a two-peaked potential barrier. However, the interpretation of this peak is ambiguous because it appears at the same excitation energy as a gross structure resonance in the (d,p) cross section. An attempt was made to resolve the question of whether the observed resonance in the ^{239}Pu(d,pf) results is due to a resonance in the fission penetrability or in the (d,p) stripping process. Fission probabilities and angular correlations for the fission of ^{240}Pu excited by the (p,p') reaction were obtained from measurements of coincident events at 7 independent fission angles. A 20-MeV proton beam was used and inelastically scattered protons were detected at 90° with an energy resolution of 150 keV (FWHM). The fragment angular correlations were fitted as a function of the excitation energy of the residual nucleus (^{240}Pu) to a series of even Legendre polynomials and the resultant fission cross section is divided by the (p,p') cross section to obtain a fission probability. Detailed structure observed in the fission probability is compared to the (d,pf) results. The angular correlations are less strongly peaked than previous (d,pf) results. This effect indicates that $\theta_p = 90°$ is not a sufficiently large angle for the plane wave approximation to be valid. This effect plus the poorer statistical accuracy of the (p,p'f) data combine to obscure the detailed structure in the angular correlation coefficients that has been observed in the (d,pf) experiments. Near the threshold the fission probability from the (p,p'f) results shows a rise to a plateau at $E^* \sim 5$ MeV with a value for the fission probability of ~½ the peak value observed in the (d,pf) results. The results are consistent with the hypothesis that the shape of the resonance in the fission probability in the (d,pf) results is dominated by the gross structure resonance in the (d,p) process. However, the magnitude of the fission probability

for the (p,p'f) reaction at $E^* \sim 5$ MeV is significantly less than would be expected for fission through fully open transition states from a $K = 0^+$ rotation band. The experimental probabilities from both (p,p'f) and (d,pf) measurements are compared with penetrability calculations for fission through a two-peaked barrier. (auth)

30785 CORRELATION ANALYSES OF THE TOTAL AND FISSION CROSS-SECTIONS OF ^{239}Pu. James, G. D.; Partick, B. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 391-401 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

A correlation analysis, of the type suggested by Egelstaff, of high-resolution ^{239}Pu total cross-section data indicates a modulation of the cross section with a spacing of about 460 eV. The regions of high-correlation coefficients are not so highly significant as those discovered for the fission cross section but they cannot be explained by a modulation of the fission widths and suggest a modification of the neutron widths. It is found that the three regions of high fission cross section below 600 eV are also regions of high total cross section and that these explain the correlations found in the total cross section. Analysis of the data between 716 eV and 5683 eV indicates a pronounced modulation of the fission cross section but no modulation of the total cross section. The fission cross-section modulations are analyzed on the assumption of a Lorentzian dependence and the parameters of this dependence are given. (auth)

30786 CHANNEL ANALYSIS OF NEUTRON-INDUCED FISSION OF ^{236}U. Huizenga, J. R. (Univ. of Rochester, N. Y.); Behkami, A. N.; Roberts, J. H. pp 403-18 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Fission-fragment angular distributions were measured for the fission of ^{236}U induced with mono-energetic neutrons of energies 400, 500, 600, 700, 800, 900 and 1100 keV. The fission fragments are detected with approximately 2π geometry with a polycarbonate resin detector. At the lower energies the experimental angular distributions are peaked in the direction of the neutron beam. However, by the time the neutron energy has reached 700 keV the angular distribution has a peak at an angle which is intermediate between the parallel and perpendicular directions to the beam. Statistical model calculations of the fission cross sections and angular distributions are performed as a function of neutron energy. These calculations are of the Hauser-Feshbach type and include all the open decay channels for fission, neutron and gamma ray emission. The calculation includes also the level-width fluctuation correction. The number and type (K,π) of transition-state fission channels and their energy parameters are varied in the calculation to give the best agreement with the experimental cross section and angular distribution data. Assignments of quantum numbers to transition states in the deformed ^{237}U nucleus and the relative heights of the postulated two-humped fission barrier for this nucleus are discussed. (auth)

30787 ANGULAR ANISOTROPY AND THE STRUCTURE OF THE FISSION BARRIER. Androsenko, Kh. D. (Inst. of Physics and Power Engineering, Obninsk, USSR); Ermagambetov, S. B.; Ignatyuk, A. V.; (and others). pp 419-37 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969). (In Russian).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Measurements are reported of the angular distributions of fragments produced in the neutron-induced fission of ^{232}Th, ^{238}U, ^{237}Np, ^{238}Pu, ^{240}Pu, ^{242}Pu and ^{241}Am target nuclei and photon-induced fission of ^{232}Th, ^{238}U, ^{238}Pu, ^{240}Pu and ^{242}Pu target nuclei. The (n,f) reaction was investigated using electrostatic generators, while the photofission reaction was studied with the help of the 12-MeV microtron. Particular attention was paid to excitation energies near the threshold. The experimental data do not fit the traditional picture of fission probability, but can be satisfactorily explained in terms of double-humped barrier concepts. In discussing the results of the measurements, the authors touch on the quasi-stationary states of the nucleus in the second valley, the structure of barriers, even-odd differences in fission probability, and the question of the penetration probability at certain energies in the case of highly deformed nuclei. (auth)

30788 CHARGED-PARTICLE STUDIES OF ISOMERIC FISSION. Metag, V.; Repnow, R.; Von Brentano, P.; Fox, J. D. (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 449-56 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Delayed fission events due to isomeric fission were produced using ^{3}He and ^{4}He beams from the Max-Planck-Institut Mp Tandem Van de Graaff accelerator. The isomeric nuclei which recoil from the target and subsequently fission in flight are detected by a square cone array of plastic foil detectors mounted along the beam direction. From the distribution of fission tracks along the plates, half-lives are calculated on the assumption that the recoil has its full momentum. In the following, the bombarded targets, the most probable reactions, the assumed final nucleus in which isomerism occurs, the bombarding energies, and the deduced half-lives are listed: ^{233}U (^{4}He, 2n) ^{235}Pu, 26.1 MeV, 20 ns; ^{235}U(^{4}He, 2n) ^{237}Pu, 26.1 MeV, 50 ns; ^{236}U(^{4}He, 2n)^{238}Pu, 26.1 MeV, about 500 ns; ^{238}U (^{4}He, 2n) ^{240}Pu, 26.1 MeV, 7 ns; ^{237}Np (^{3}He, pn)^{238}Pu, 26.1 and 30 MeV, about 500 ns; ^{237}Np (^{3}He, p2n) ^{237}Pu, 26.1 and 30 MeV, 40 ns; ^{237}Np(^{4}He, 2n)^{239}Am, 26.1 MeV, 110 ns; ^{239}Pu (^{3}He, p2n) ^{239}Am, 30 MeV, 110 ns; ^{239}Pu (^{4}He, 2n)^{241}Cm, 26.1 MeV, 20 ns; ^{242}Pu + ^{3}He, 30 MeV, half-life of the order of 1 μs; ^{241}Am + ^{3}He leading to Cm or Bk, 30 MeV, 45 ns. As only a few cross bombardments were made and the assignment of the reaction mode is often not unique, many of the isotopic assignments are somewhat tentative. (auth)

30789 VARIATION OF KINETIC ENERGY OF FRAGMENTS IN FISSION OF ^{235}U WITH 0.006 TO 20 eV NEUTRONS. Bochvarov, S.; Dermendzhiev, E.; Kashukeev, N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 465-73 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969). (In Russian).

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Using a neutron spectrometer working in the energy range between 0.006 and 20 eV, the variation in fragment kinetic energies (E_K) was studied by the method of relative yield (W) measurements for resonances of ^{235}U. It was found that the resonances at 0.29, 2.04, 3.14, 4.84, and 7.09 eV can be sorted in a group of resonances with small values of W and E_K. The resonances at 1.14, 3.60, 6.40, 8.78, 12.4, and 19.3 eV form a group with big values of W and E_K. Comparison of W with radiochemical data on fragment yields at thermal and resonance region of ^{235}U showed that E_K is larger at more asymmetrical fission. From the values W(I) and W(II) for the two groups of resonances, the change in the average kinetic energy of fragments $2\Delta\bar{E}_K = 0.74 \pm 0.32$ MeV was determined. (auth)

30790 NEUTRON MULTIPLICITY MEASUREMENTS FOR ^{233}U, ^{235}U, AND ^{239}Pu RESONANCE FISSION. Weinstein, S.; Reed, R.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). pp 477-90 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The dependence of the fission-neutron multiplicity on incident neutron energy was investigated for ^{233}U, ^{235}U and ^{239}Pu. The experiments used on electron linear accelerator as a source of neutrons, a 70-cm diameter gadolinium-loaded scintillation tank to detect the fission neutrons, and multiplate ionization chambers to detect the fission events. The results of measurements for 20 resolved resonances in ^{239}Pu below 100 eV show that the $\bar{\nu}$ values fall into two groups. The grouping is strongly correlated with the spins of the individual resonances with the J = 0 levels corresponding to high values of neutron multiplicity and the J = 1 levels corresponding to low values. The average multiplicity for the J = 0 group is about 3% higher than the average for the J = 1 group. The observed multiplicity grouping would lead to assignments of J = 1 for the 0.298- and 23.9-eV levels, both of which were previously unassigned. Variations in fission-neutron multiplicity were observed among the low-energy resonances of both ^{233}U (below 10 eV) and ^{238}U (below 25 eV), and spin assignments were made for 13 resonances in ^{235}U. The results in the energy region from 0.01 to 0.3 eV show that the multiplicity is independent of energy for ^{235}U but show a statistically significant decrease for ^{236}U in going from 0.3 to 0.01 eV. (auth)

30791 STUDY OF THE NEUTRON EMISSION OF CALIFORNIUM-252 FRAGMENTS AS A FUNCTION OF THEIR CHARGE. Nifenecker, H. (CEN, Saclay, France); Frehaut, J.; Soleihac, M. pp 491-504 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969). (In French).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The charge, energy and neutron emission of californium-252 fission fragments were measured simultaneously. From these measurements the variations in the average number of neutrons emitted were obtained as a function of the charge and energy of

the fragments. The variation in the average number ν of the neutrons emitted, studied as a function of charge, reveals the fine structures which are correlated with the fine structures of the mass distributions. These fine structures, on the other hand, do not appear to be connected with the parity of the fragment charge. The results giving the variations of $(d\nu)/(dE_T)$, of the kinetic energy of the fragments and of the widths of the different distributions as a function of Z are presented and discussed. (auth)

30792 NEUTRON EMISSION IN THE FISSION OF ^{213}At. Plasil, F.; Ferguson, R. L.; Schmitt, H. W. (Oak Ridge National Lab., Tenn.). pp 505-17 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

A thin target of ^{209}Bi was bombarded with 53.25-MeV ^{4}He ions at the Oak Ridge Isochronous Cyclotron. Two silicon surface-barrier detectors were used to measure kinetic energies of fragment pairs and to provide timing pulses for the measurement of the velocity of one of the fragments. Three pulse-heights, related to the two fragment energies and to the time-of-flight were recorded event-by-event. These correlated data were used to calculate pre-neutron and post-neutron emission masses and total kinetic energies. The average numbers of neutrons emitted from single fragments and from both fragments together were obtained as functions of fragment mass and total kinetic energy. Distributions in fragment mass and total kinetic energy, before and after neutron emission, were also obtained. The results are presented in terms of several simple distributions, such as the average number of neutrons emitted as a function of fragment mass, and also in terms of correlated distributions, such as the yield as a function of both mass and total kinetic energy. The distributions in fragment mass and total kinetic energy peak at symmetry are in agreement with earlier results. The average total kinetic energy is 146.2 MeV before neutron emission and 141.3 MeV after neutron emission. The average number of neutrons emitted from single fragments rises monotonically from about 2.3 neutrons at fragment mass 90 to 5 neutrons at fragment mass 120. This trend is in accord with trends predicted by the liquid-drop theory of fission, but the slope of the average neutron number versus mass curve is considerably greater than predicted by theory. The average total number of neutrons emitted per fission from both fragments is 7.4 ± 0.5. The available energy for given fragment mass pairs, calculated from mass tables, is compared with the sum of the measured total kinetic energy and the two fragment excitation energies estimated from the measured neutron numbers. (auth)

30793 PROMPT GAMMA RAYS EMITTED FROM INDIVIDUAL FRAGMENTS IN NEUTRON-INDUCED FISSION. Horsch, F.; Michaelis, W. (Kernforschungszentrum, Karlsruhe, Ger.). pp 527-43 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Prompt gamma rays associated with moving fission fragments of specific masses were observed in thermal neutron-induced fission of ^{235}U. The geometrical layout of the apparatus prevents detection of photons emitted from stopped fragments and determines the effective time resolution to about 1 ns after fission. Spectra are measured by means of a high-resolution Ge(Li) detector with 3.5% photopeak efficiency for ^{60}Co. An 8" $\phi \times 9$" NaI (Tl) anti-Compton shield suppresses the Compton distribution in the spectra and the recording of events produced by fast fission neutrons. The coincident fission-fragment masses are deduced from their correlated kinetic energies as measured by two Si solid-state detectors. The observed Doppler shift in gamma-ray energy allows the assignment of lines to single members of fragment pairs. Data are processed in a $256 \times 256 \times 2048$ channel matrix. The main objective of these experiments is a study of the properties of individual neutron-rich nuclei far off the stability line. (auth)

30794 MASS DEPENDENCE OF ANISOTROPY AND YIELD OF PROMPT γ-RAYS IN ^{235}U THERMAL FISSION. Armbruster, P.; Hossfeld, F.; Labus, H.; Reichelt, K. (Kernforschungsanlage, Juelich, Ger.). pp 545-59 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The yield of prompt γ-rays and the anisotropy of the angular correlation, γ-ray versus fission product, were measured. A time-of-flight and energy measurement on single fragments gave the mass. The γ-rays emitted in flight were observed in the time interval of $3 \times 10^{-12} - 2 \times 10^{-10}$ s after fission through a slit collimator of adjustable width. Only those γ-rays emitted by the fragment the mass of which was detected in the time-of-flight energy spectrometer were recorded. γ-rays were detected in the energy range between 0.1 and 1.5 MeV by plastic scintillators for angles of emission of 30, 90 and 150°. (auth)

30795 ANGULAR DISTRIBUTION OF GAMMA RAYS FROM THE FISSION OF ^{235}U INDUCED BY 14-MeV NEUTRONS. Jeki, L.; Kluge, Gy.; Lajtai, A. (Central Research Inst. for Physics, Budapest). pp 561-5 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Experiments are reported which were performed to study the angular distribution of the gamma radiation following fast-neutron-induced nuclear fission. The investigations were, in particular, focused on the influence which the angular momentum imparted to the compound nucleus by the fast neutrons has on the angular distribution of the γ-rays. The fission of ^{236}U is induced by 14-MeV-energy neutrons from the T(d,n) α reaction. The fission fragments are detected by a gas-scintillation counter filled with a mixture of Ar and Ni gases, the γ-rays by 5 cm × 5 cm NaI(Tl) crystal with an energy threshold of 120 keV. The intensity of the γ-rays is measured at 90 and 174° to the direction of fragment motion. The flight times of fission neutrons and γ-rays are measured with a 20-ns overlap-type time-to-pulse height converter while the background was covered simultaneously with another converter delayed with respect to the former. The signals from both converters are analyzed by a multichannel analyzer with divisible memory. The flight path, which is chosen to be about 70 cm, makes it possible to separate the neutron from the gamma counts. The geometry is designed to keep the direction of the outflying fission fragments nearly the same as that of the incident fast neutrons. In this way the angular momenta of the fast neutrons are normal to the flight path of the fragments. The measured gamma intensities are extrapolated to 180° on a computer using Strutinski's formula $n(\vartheta) \sim 1 + B \sin \vartheta$. On transformation of the measured data from the laboratory system to the system of fragments the anisotropy is found to be $A = I(180°)/I(90°) = 1.33 \pm 0.05$. The main angular momentum of fission fragments is calculated from the anisotropy as 15 h units. As compared with the thermal-neutron-induced fission the present results indicate an additional contribution from the angular momentum of the compound nucleus to the anisotropy of the angular distribution attributed to the effect of the angular momentum imparted to the fission fragments by noncollinear scission. (auth)

30796 DELAYED NEUTRONS IN FISSION. Amiel, S. (Soreq Nuclear Research Centre, Yavne, Israel). pp 569-90 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

A survey is given of the recent work on delayed neutron emission from fission products. The experimental, phenomenological and theoretical aspects are reviewed briefly and discussed in the light of the systematics of fission and nuclear structure. (auth)

30797 DELAYED NEUTRON PRECURSORS IN FISSION OF ^{235}U BY THERMAL NEUTRONS. Schuessler, H. D.; Ahrens, H.; Folger, H.; Franz, H.; Grimm, W.; Herrmann, G.; Kratz, J. V.; Kratz, K. L. (Univ., Mainz). pp 591-604 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

A search for new delayed neutron precursors was performed by using thermal-neutron-induced fission of ^{235}U as the production process. Individual elements were chemically separated by rapid automatic techniques which permit counting to be started within a few seconds after irradiation, in the fastest procedure within 0.5 s. The chemical step consists of isotopic or ion exchange with preformed precipitates (Br, I, Rb, Cs, Sr), of extraction into quasi-solid reagents (Y, Zr, Nb), of volatilization as hydrides (As, Se, Sb, Te), or of recoil reactions with methane forming volatile methyl halides (Br, I). Several new precursors were found, e.g., 1.7 s ^{88}Se, 0.5 s ^{91}Br, 0.8 s ^{140}I, and 0.4 s ^{141}I. The contributions of individual precursors to the group yields in fission of ^{235}U with thermal neutrons were measured by comparing neutron counting rates of separated and unseparated samples. In the 2-s, 6-s, 22-s, and 55-s groups, the total abundances of the identified precursors agree with the group yields. From these abundances and estimated cumulative fission yields, neutron emission probabilities (P_n) of precursor nuclides were deduced. In addition, the P_n-value of ^{137}I was directly determined by measuring its beta and neutron emission rate. (auth)

30798 SEARCH FOR LONG-LIVED DELAYED NEUTRON GROUPS: PHOTOFISSION CAUSED BY FISSION-PRODUCT

GAMMA-RAYS. Tomlinson, L.; Hurdus, M. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 605-20 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

A search was made for long-lived delayed neutron groups with half-lives greater than 55 s in the thermal neutron fission of ^{235}U. The neutron counter used in these experiments was designed to allow one to distinguish between true delayed neutrons and neutrons produced by (γ,n) reactions on D and Be impurities. The experimental results showed the existence of apparent delayed neutron groups with half-lives greater than 55 s and of very low intensity. These were shown to be neither true delayed neutrons, nor photoneutrons from D or Be but were prompt neutrons from the photofission of ^{238}U and ^{235}U. Photofission is produced by high energy (>4.5 MeV) gamma rays emitted from certain fission products. The intensity of the neutrons produced in this way decays with the half-lives of the fission products causing the photofission. The half-lives of the "photofission groups" were 3.1, 17 and 111 min, with absolute yields of 1×10^{-8}, 1×10^{-11} and 2×10^{-12} neutrons/fission respectively, under the best conditions. By surrounding the irradiated uranium sample with large amounts of ^{238}U, ^{235}U or ^{239}Pu, it was possible to obtain relative photofission cross sections for these nuclides. The values obtained were: 1.0, 1.4 and 10.8 for ^{238}U, ^{235}U and ^{239}Pu respectively, in agreement with known cross sections. It is unlikely that photofission groups with $t_{\frac{1}{2}} \geq 3.1$ min will, under any experimental or reactor conditions, be a significant fraction of the total delayed neutron yield. However, shorter-lived photofission groups ($t_{\frac{1}{2}} < 3$ min) may be important, but their yields cannot be estimated at present because of a lack of data. The most favorable case is ^{239}Pu, where the photofission cross section is high and the delayed neutron yield is low compared to other nuclides. From the experimental results, upper limit values were calculated for the neutron branching ratios of ^{91}Rb, ^{148}Cs, ^{96}Y, and ^{133}Sb. These were: $\leq 0.7\%$, $\leq 0.1\%$, $\leq 5 \times 10^{-6}\%$ and $\leq 3 \times 10^{-6}\%$, respectively. (auth)

30799 SOME INVESTIGATIONS OF HIGH-ENERGY GAMMA RAYS FROM SHORT-LIVED FISSION PRODUCTS. Large, N. R.; Bullock, R. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 637-45 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

A knowledge of the high energy γ-rays emitted by fission products is of considerable value in fission studies. The use of Ge(Li) detectors makes possible accurate measurement of these γ-rays. The γ-spectra of a number of fission products with half-lives of a few minutes to a few hours were examined by means of a Ge(Li) detector; the fission products selected were chosen from those likely to emit γ-rays of over 2.5 MeV. By comparison of these and other known spectra with the γ-spectrum of irradiated ^{235}U the main contributors to the high-energy portion of the fission product spectrum were ascertained. (auth)

30800 MASS, ENERGY AND CHARGE DISTRIBUTION IN FISSION. Pappas, A. C. (Univ. of Oslo, Blindern, Norway); Alstad, J.; Hageboe, E. pp 669-700 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Potentialities and limitations of modern techniques used for studies of mass and charge distribution in fission are discussed. Recent experimental developments and new findings concerning the distribution of mass, charge, and of energy—as far as the latter bear on these distributions—are reviewed and commented on. This concerns results from thermal-, low-, medium- and high-energy-particle-induced fission and is limited to heavy nuclei in a brief phenomenological way. Initial and final mass distributions as determined by pure instrumental methods are discussed, and the final distributions are compared with radiochemical results. The asymmetry and fine structure in these distributions are commented on. The results from high-energy-induced fission are presented in view of the fragment shell theory and the two-fission-mode hypothesis. It is shown that asymmetric fission persists to high bombarding energies. Recent results from range studies in high-energy-induced fission are discussed, and the importance of the observation that the scission distance increases with increasing energy of the fissioning nucleus is stressed. In connection with charge distribution and dispersion, emphasis is laid on the problem of correction of measured masses due to neutron emission which ought to be known for single fragments and not for groups of fragments as at present. The implication of this on the charge dispersion is stressed. Experimental studies of charge dispersion widths (Gaussian) in thermal-neutron-induced fission are discussed as well as shell and odd-even effects on these distributions. The equal-charge displacement hypothesis in the pre-neutron emission and closed-shell representation still gives the best fit to the experimental Z_p dependence on the initial mass. The review includes also charged-particle-induced fission in the medium-energy range and in high-energy fission. In the latter the observation of the trend of N_p/Z_p with the fragment mass is presented and correlated with the symmetric peak of the mass distribution. (auth)

30801 NUCLEAR CHARGE DISPERSION IN THE FISSION OF HEAVY ELEMENTS BY MEDIUM-ENERGY PROTONS. Yaffe, L. (McGill Univ., Montreal). pp 701-15 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Independent yields were determined for nuclides with masses $129 \leq A \leq 140$ produced in the fission of ^{232}Th, ^{233}U, ^{235}U, ^{238}U, and ^{239}Pu by protons of energies up to 100 MeV. Excitation functions were compared for the nuclides produced in the different fissioning systems. The importance of the neutron-to-proton ratio, (N/Z), in the target is evident from this comparison. Neutron-deficient species occur in high yield from targets with low N/Z ratios compared with their production at the same energies from targets with high N/Z ratios. Charge dispersion curves were obtained for all these systems. The curves broaden with increasing bombardment energy and the most probable charge, Z_p, moves towards stability. It is shown that the distance from stability, $Z_A - Z_p$, is a function of the neutron-to-proton ratio of the target. From this basis it is possible to predict the most probable charge in fission for systems yet unstudied. Calculations were made to calculate Z_p on the basis of the unchanged-charge-distribution and equal-charge-displacement postulates. Calculations are also made from Z_p to determine the average number of neutrons emitted during fission at these energies. (auth)

30802 DEPENDENCE OF FISSION-FRAGMENT TOTAL KINETIC-ENERGY AND MASS DISTRIBUTIONS ON THE EXCITATION ENERGY AND ANGULAR-MOMENTUM DISTRIBUTION OF THE FISSIONING NUCLIDE ^{210}Po. Unik, J. P. (Argonne National Lab., Ill.); Cuninghame, J. G.; Croall, I. F. pp 717-29 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The fission of ^{210}Po, produced by three different nuclear reactions ($^{209}Bi + p$, $^{206}Pb + \alpha$ and $^{198}Pt + {}^{12}C$), was studied in detail in order to establish the dependence of various scission-point properties on the excitation energy and angular-momentum distribution of the fissioning nucleus. Excitation energies of 31, 44 and 57 MeV were chosen so as to give reasonable fission cross sections, while avoiding a large contribution from second-chance fission. The experiments were conducted on a beam line of the Harwell Variable Energy Cyclotron. The mean-fragment total-kinetic-energy release was found to be dependent on the ^{210}Po excitation energy and angular-momentum distribution. The variances of the total-kinetic energy and mass distributions were found to be strongly dependent on excitation energy but not on angular momentum. The experimental results of this work were found to be in good agreement with the theoretical liquid-drop-model calculations of Nix and Swiatecki. (auth)

30803 FISSION YIELDS AND RECOIL RANGES DETERMINED BY A Ge(Li) DETECTOR. Dange, S. P.; Jain, H. C.; Manohar, S. B.; Satyaprakash, K.; Ramaniah, M. V.; Ramaswami, A.; Rengan, K. (Bhabha Atomic Research Centre, Trombay, India). pp 741-57 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The excellent resolution of gamma rays by Ge(Li) detectors is used to determine ^{239}Pu fission yields and recoil ranges of fission products from ^{233}U and ^{235}Pu. A combination of a 2-cm^3 Ge(Li) detector and a low-noise, room-temperature FET preamplifier combination giving a FWHM of 3.6 keV for a 122-keV gamma-ray was employed. Irradiation and cooling times were optimized in order to obtain best resolution for different fission products. The purity of each photopeak used was ascertained by following the decay and determining the half-life. As part of a program on determining fission yields of several heavy-element nuclei, fission yields of ^{239}Pu were determined by this technique. Thin, electroplated targets of ^{239}Pu and ^{235}U were simultaneously irradiated with neutrons and the recoiling fission fragments were collected in superpure aluminium foils. From an analysis of the gamma-ray spectra of fission products in the catcher foils, the yields of various nuclides in the thermal-neutron-induced fission of ^{239}Pu were determined

relative to that of ^{235}U. These yields were compared with available radiochemical values. Recoil ranges of fission products from ^{233}U and ^{239}Pu in aluminium were also determined gamma-spectrometrically and compared with radiochemical values. This method affords determination of fission yields with an accuracy of 2–5% and ranges with an accuracy of 1–2%. (auth)

30804 FISSION OF COMPOUND NUCLEI IN THE REGION $(Z^2/A) > 37$. Karamyan, S. A.; Oganesyan, Yu. Ts.; Pustyl'nik, B. I.; Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 759-80 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969). (In Russian).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The angular mass and charge distributions of the fragments in fission of compound nuclei with Z between 85 and 110, and excitation energy between 40 and 120 MeV were studied. The compound nuclei were created by the bombardment with heavy ions. The data on anisotropy of the fission fragments were used to obtain the values of effective moments of inertia for scissioning nuclei at the saddle point and Z^2/A near to the critical value. It was shown that the effective moment of inertia is a simple function of the fission parameter (Z^2/A) and does not depend on the energy of the excited nucleus. The results are compared with the prediction of the drop model fission theory in respect to the shape of nuclei at the saddle point. The investigations of the mass and charge distribution disclose a sharp increase of charge and mass dispersion of the fragments (as a function of Z^2/A) at $Z/A > 37$. A strong dependence of charge dispersion on asymmetry of fission was observed. The most probable charge of the fission fragments differs substantially from those calculated on the basis of the hypothesis on charge proportionality. It agrees with the calculations based on the hypothesis of uniform charge displacement and with the condition of a minimum of potential energy in the system of the fragments. The charge dispersion of the fragment depends only weakly on the excitation energy of the scissioned nuclei, but the mass distribution broadens substantially with the rise of the excitation energy. The results obtained testify that shape of the nuclei at the moment of fission changes significantly with Z^2/A, i.e., the final division of the nucleus in two fragments occurs at different stages of the nucleus deformation. Based on the extrapolation of mass and charge distribution, a semi-quantitative analysis of possibilities to utilize the fission reaction caused by accelerated heavy ions (of ^{136}Xe type) as a tool for artificial synthesis of neutron-rich isotopes of very heavy elements (of type $^{298}114$) was made. The results on number and angle distribution of neutrons from heavy-ion-induced fission are also presented. The data on $\bar{\nu}$ agree with the values obtained by studying mass and charge fragments' distribution in the same reaction. A qualitative exploration of the obtained experimental data on fission of excited nuclei with $Z^2/A > 37$ is given. The quantitative description of the detected phenomena requires further theoretical studies. (auth)

30805 HIGH-RESOLUTION STUDIES OF K X-RAY EMISSION AND THE DISTRIBUTION OF MASS AND NUCLEAR CHARGE IN THE THERMAL-NEUTRON-INDUCED FISSION OF ^{233}U, ^{235}U, AND ^{239}Pu. Glendenin, L. E.; Griffin, H. C.; Reisdorf, W.; Unik, J. P. (Argonne National Lab., Ill.). pp 781-802 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The emission of K X-rays by nission fragments as a function of fragment mass A and nuclear charge (element) Z was investigated in the thermal-neutron-induced fission of ^{233}U, ^{235}U and ^{239}Pu. Fission-fragment K X-ray spectra were obtained with a Si(Li) detector in coincidence with a pair of surface-barrier detectors which measured the kinetic energies of the complementary fragments for the determination of their masses. The data were recorded event-by-event in a multiparameter system. The yields of K X-rays per fission emitted by fragments in $t < 1$ ns are as follows: ^{233}U - 0.037 (light fragment group), 0.125 (heavy group); ^{235}U - 0.043, 0.120; and ^{239}Pu - 0.070, 0.134. The high resolving power of the X-ray detector (FWHM ≈ 800 eV) makes possible a computer analysis of the characteristic K X-ray spectra giving the relative contribution from each element. Near closed nucleon shells it is found that the average K X-ray yields for odd-Z nuclei are enhanced by a factor of two to three relative to the yields from even-Z nuclei. Away from the closed shells the yields increase rapidly with Z and A while the odd-even Z fluctuations tend to be substantially smaller. Differences in average K X-ray yields for a given Z among the three fissionable nuclei are consistent with an observed A (isotopic) dependence and a fixed yield of K X-ray emission for a given fission fragment nucleus (Z,A) in thermal-neutron-induced fission. In spite of the strong dependence of the K X-ray yields on Z and A, information on the primary charge distribution in fusion in terms of average nuclear charges as a function of the fragment masses and on charge dispersion width can be obtained. The deviations of the mean primary charges of the fragments from that given by the charge densities of the fissioning nuclei lie in the range of 0.4 to 0.7 charge units for the complementary mass regions 85–110 and 130–155. The primary charge dispersion is narrower (FWHM = 1.10 ± 0.15 charge units) than the post-neutron-emission charge dispersion (FWHM = 1.56 ± 0.12) determined radiochemically. These results appear to have little dependence on total fragment kinetic energy at given mass splits. (auth)

30806 PRODUCTS FROM THERMAL-NEUTRON-INDUCED FISSION OF ^{235}U: A CORRELATION OF RADIOCHEMICAL CHARGE AND MASS DISTRIBUTION DATA. Wahl, A. C.; Norris, A. E.; Rouse, R. A.; Williams, J. C. (Washington Univ., St. Louis). pp 813-43 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Mass and charge distribution data for fission products after prompt neutron emission were compiled and used to determine ν_t, the average number of prompt neutrons emitted in forming products with complementary mass numbers ($A_l + A_h = 236 - \nu_t$), and also Z_p and σ, parameters in a new charge-distribution formulation. The compilation includes both new data and older data, some of it re-evaluated using current values for fission-product half-lives and delayed-neutron yields. The values of ν_t determined using Terrell's method with normalized chain yields are generally consistent with results derived from direct physical measurements. The Z_p values, the most probable (or average) charge for isobars derived from radiochemical data are also consistent with those determined by physical methods involving measurement of X-rays or beta-decay chain lengths. The new Gaussian width parameter σ has a value of 0.56 ± 0.06, which corresponds to a full-width at half-maximum, of 1.50 ± 0.12 charge units. The new charge-distribution formulation was used with the normalized chain yields to estimate "normal" independent yields for all fission products, for elements, anf for isotones. The estimated "normal" yields for complementary elements ($Z_l + Z_h = 92$) are essentially equal, as they should be. Comparison of estimated "normal" yields for elements with sums of independent experimental yields for the isotopes shows, where sufficient data exist, that even-Z elements have higher yields than odd-Z elements. The maximum in the "normal" isotone-yield curve occurs at N = 82, and the sum of the measured independent yields for the N = 82 isotones is ~30% higher. It is shown that the probable modes of fission (those giving asymmetric mass and charge division) occur only when the heavy fragment has 50 or more protons. (auth)

30807 USE OF ANGULAR-DISTRIBUTION MEASUREMENTS OF FISSION FRAGMENTS EMITTED FROM SINGLE CRYSTALS FOR DETERMINING THE LIFETIMES OF EXCITED COMPOUND NUCLEI. Gibson, W. M. (Bell Telephone Labs., Murray Hill, N. J.); Nielsen, K. O. pp 861-78 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The angular distribution of fission fragments emitted from uranium oxide crystals bombarded with protons in the energy range 9–12 MeV has been measured by using plastic fission-track detectors. The protein energies, and with these the compound-nuclei excitation energies, were selected to give second-chance fission ^{238}Np compound nuclei with life-times in the range detectable by this technique. An upper limit of $\leq 7 \times 10^{-17}$ s has been established for the "effective lifetime" of compound nuclei formed by 12-MeV proton bombardment of ^{238}U. A value of $1.4 \pm 0.6 \times 10^{-16}$ s has been measured for the total lifetime and $2.5 \pm 1.2 \times 10^{-16}$ s for the partial fission lifetime of ^{238}Np compound nuclei at an average excitation energy of ~7.3 MeV. The measurements were found to be sensitive to random scattering effects. Experimental determination and analytical treatment of such effects are discussed. (auth)

30808 OCTUPOLE STATES OF EVEN–EVEN NUCLEI IN THE REGION OF 150 less than or equal to A less than or equal to 176. Malov, L. A.; Solov'ev, V. G.; Fedotov, S. I. (Joint Inst. of Nuclear Research, Dubna). Dokl. Akad. Nauk SSSR; 189: 987-90(11 Dec 1969). (In Russian).

The energies and structures of the octupole states of a large number of deformed even-even nuclei were calculated on a computer with the use of single-particle energies and wave functions of a Saxon–Woods potential having a number of advantages compared to a Nilsson potential. The constant of the octupole-octupole interaction was selected so as to obtain the best agreement of the calculated energy values of the first octupole states with the corresponding experimental data. The data show that for most nuclei the octupole states with $K^\pi = 0^-$ are more strongly collectivized

than the states with $K^\pi = 1^-$ and 2^-. In ^{150}Nd and isotopes of Sm and Gd the first levels with $K^\pi = 0^-$, 1^- and 2^- are very strongly collectivized. A large number of quasi-two-particle states contribute to the wave functions. It should be noted that collectivization of states with $K^\pi = 1^-$ and 2^- is greatly increased as compared with calculations carried out by the Nilsson scheme. (TTT)

30809 PRODUKTY MGNOVENNOGO DELENIYA ^{235}U, ^{238}U, ^{239}Pu V INTERVALE 0–1 CH. SPRAVOCHNIK. (Products of Prompt Fission of ^{235}U, ^{238}U, and ^{239}Pu in the Range from 0 to 1 Hour. Handbook). Greshilov, A. A.; Kooashkin, V. M.; Dement'ev, S. I. Moscow; Atomizdat (1969). 105p.

Tabulated data are given on the magnitudes of activity of prompt fission products of ^{235}U, ^{238}U, and ^{239}Pu in the range from 0 to 1 h following the fission. Data were collected according to the individual, cumulative, and total yields and, also, as a chain of fission product decays. Gamma-radiation spectra of the fission products and β-decay products are included. (R.V.J.)

30810 MAGNETIC MOMENT OF THE 133-keV LEVEL OF ^{131}Cs. Begzhanov, R. B.; Gaffarov, Dzh.; Salikhbaev, K. T. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 5, 23-5(1969). (In Russian).

Results are given of studies made of the integral correlation of the γ-γ cascade (at 486 to 133 keV) in ^{131}G and the g-factor obtained by integral method. (R.V.J.)

30811 SPONTANEOUS FISSION HALF-LIFE OF ^{244}Cm. Barton, David Maxwell; Koontz, Philip Grant (Los Alamos Scientific Lab., N. Mex.). J. Inorg. Nucl. Chem.; 32: 769-75(Mar 1970).

The partial half-life for spontaneous fission of a 94 per cent sample of ^{244}Cm was determined to be $(1.250 \pm 0.007) \times 10^7$ yr. (auth)

30812 SEARCH FOR ^{172}Hf ALPHA DECAY. Toth, K. S.; Hahn, R. L.; Benis, C. E.; Handley, T. H.; Roche, M. F. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 32: 1051-2(Mar 1970).

The α-decay energy of the doubly even nuclide ^{172}Hf has been estimated to be in the range ~3.0 to 2.7 MeV. If the upper value were correct the α-decay half-life would be sufficiently short to allow detection of the α-decay branch using standard radiochemical techniques. A search for α-decay in ^{172}Hf was undertaken. Long-lived ^{172}Hf was produced by bombarding lutetium oxide of natural isotopic abundance with cyclotron accelerated protons, the proton bombarding energy being selected to be 40 MeV so that the (p,4n) reaction was expected to predominate. The hafnium activity was separated by TTA-xylene extraction in HCl medium. After a year the hafnium fraction was again separated from the Lu daughters that had grown in, after which the only activity remaining in the hafnium fraction was due to ^{172}Hf. A suitable source was then prepared and assayed for alpha decay over a period of 1 week, during which no alpha groups in the energy range 2.5 to 3.5 MeV were observed. From other experiments conducted 3 months after the second chemical separation it was concluded that the upper limit for the ^{172}Hfα/ total branching ratio was $<4.4 \times 10^{-11}$, and from this ratio the α-decay half-life of ^{172}Hf must be $>1.1 \times 10^{11}$ yr. This experimental limit for the half-life yielded a limit of <2.8 MeV for the alpha decay energy. (UK)

30813 EXCITED LEVELS OF ^{233}Pa OBTAINED BY β-DECAY OF ^{233}Th. Sebille, Claire; Bastin, Genevieve; Leang, Chin Fan; Piepenbring, Robert (CNRS, Orsay, France. CNRS, Strasbourg). Compt. Rend., Ser. B; 270: 354-7(2 Feb 1970). (In French).

Experiments of multidimensional γ-γ coincidences with two Ge(Li) junctions were performed and a partial level scheme is proposed for ^{233}Pa. (auth) (France)

30814 NUCLEAR PHOTOACTIVATION OF ^{115}In. Boivin, Michel (Laboratoire de Chimie Physique, Paris). Compt. Rend., Ser. B; 269: 929-31(3 Nov 1969). (In French).

By a previously described method the photoactivation of indium-113 was studied from samples of natural indium. Four nuclear levels were shown at 1025, 1130, and 1630 keV. The corresponding cross sections were determined and plausible characteristics were proposed for these levels. (tr-auth)

30815 DIRECT PROCESSES IN REACTION (n,2n) ON HEAVY NUCLEI. Ezhov, S. N.; Ol'khovskii, V. S.; Prokopets, G. A.; Strizhak, V. I. (Kiev State Univ.). Yadern. Fiz.; 11: 122-30 (1970). (In Russian).

The reaction (n, 2n) at E_n = 14 MeV on heavy nuclei is taken as a process of direct scattering with knock out using the distorted wave method in the Born approximation with an account of the identity of the nucleons. General formulas are obtained. Double differential cross sections for ^{209}Bi and ^{208}Pb are calculated and compared with the experiment. (auth)

30816 α DECAY OF SUPERHEAVY NUCLEI. Muzychka, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 105-10(1970). (In Russian).

Alpha decay energies of superheavy nuclei were estimated by means of the Strutinsky method. The effect of the one-particle potential parameters on the calculations of α decay was investigated. The values of the half-lives of superheavy nuclei are obtained. (auth)

30817 BAND MIXING IN ^{167}Er. Michaelis, W.; Weller, F.; Fanger, U.; Gaeta, R.; Markus, G.; Ottmar, H.; Schmidt, H. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys.; A143: 225-54(1970).

The level structure of ^{167}Er and the de-excitation mechanism in this nucleus were studied by radiative capture of thermal neutrons in ^{166}Er. High-resolution measurements of the gamma-ray spectrum were performed using a Ge(Li) anti-Compton spectrometer in the low-energy region and a Ge(Li) pair spectrometer for the high-energy transitions. Coincidence relationships were obtained from measurements with a Ge(Li)–NaI(Tl) coincidence apparatus. The target was Er_2O_3 enriched to 95.6% in ^{166}Er thus corresponding to a cross-section contribution of (68.8)% for ^{166}Er. More than 350 gamma-ray lines were detected in the spectrum. Isotope assignment was achieved by comparison of the spectra with those obtained from a sample of natural erbium. The high accuracy of the data and the coincidence results allow the construction of a transition diagram up to 1.5 MeV excitation energy. A large number of the observed energy levels were assigned to specific configurations and their superimposed rotational bands. Detailed analysis of the data suggests considerable mixing between Nilsson states and the quadrupole vibrations Q_{22}, Q_{2-2} and Q_{20}. Theoretical calculations were performed which take into account pair correlations, quasi-particle-phonon interaction, rotation-vibration interaction and Coriolis coupling. It is shown that neglect of pair correlations leads to unreasonable matrix elements. While quasi-particle-phonon interaction and Coriolis coupling have decisive influence on the level structure and the de-excitation mechanism, the effects due to rotation-vibration interaction are in general small. The model predicts the energy and structure of individual levels, branching ratios for gamma-ray transitions, multipole mixtures and partial gamma-ray half-lives. In most cases, good agreement is achieved between the theoretical calculations and the experimental results. The neutron separation energy was found to be 6436.15 ± 0.48 keV. (auth)

30818 ISOMERIC STATES IN ODD-N ISOTOPES OF Sm, Gd, Dy, AND Er ASCRIBED TO THE $1/2^-|505|$ NILSSON CONFIGURATION. Borggreen, J.; Sletten, G. (Univ. of Copenhagen). Nucl. Phys.; A143: 255-76(1970).

Experimental results on previously unreported micro- and millisecond isomers in odd-N isotopes of Sm, Gd, Dy and Er are presented. The activities are produced by pulsed beams of d, α or ^{3}He. The isomeric levels are in all cases ascribed to the $1/2^-$ [505] orbital, and in several cases a decay scheme is proposed. (auth)

30819 THE DECAY OF 20 MIN ^{115g}Ag. Hnatowich, D. J.; Coryell, C. D. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. Nucl. Phys.; A143: 289-303(1970).

The decay of 20 min ^{115}Ag was studied using Ge(Li) and NaI(Tl) detectors, and 4096-channel pulse-height analysers. This decay was found to involve at least 66 γ-rays. A partial decay scheme of ^{115}Ag, which includes 40 of the γ-rays, was constructed from the results of $\gamma\gamma$ and $\beta\gamma$ coincidence experiments. A set of negative parity levels was found in ^{115}Cd that is remarkably analogous to negative parity levels found in a recent study of the 5.3 h ^{113}Ag decay. In ^{115}Cd, as in ^{113}Cd, one of the negative parity states is believed to be a $9/2^-$ state. The existence of this state has been explained as a member of an $h_{11/2}$ three-quasiparticle multiplet. (auth)

30820 THE MEAN LIVES OF THE FIRST EXCITED STATES IN ^{181}Ta AND ^{165}Ho. Armbruster, R.; Dar, Y.; Gerber, J.; Macher, A.; Vivien, J. P. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Phys.; A143: 315-25(1970).

The mean lives of the first excited states in ^{181}Ta and ^{165}Ho were measured with the microwave method. The results obtained are $\tau(^{181}\text{Ta}) = 61.4 \pm 5.4$ ps, $\tau(^{165}\text{Ho}) = 40.6 \pm 3.4$ ps. The M1 reduced transition probabilities are calculated and the values of $|g_K - g_R|$ are found to be in agreement with those from higher transitions in the ground state rotational bands of these nuclei. (auth)

30821 INVESTIGATION OF (γ,n) REACTIONS RESULTING IN PRODUCTION OF SPONTANEOUSLY FISSIBLE Am ISOMERS. Iangrskii, Yu. P.; Markov, B. N.; Tsipenyuk, Yu. M. (Joint Inst. for Nuclear Research, Dubna, USSR. Inst. of Physical Problems, Moscow). Yadern. Fiz.; 11: 54-8(1970). (In Russian).

Production of spontaneously fissible isomers ^{240}Am and ^{242}Am

in (γ,n) reactions on isotopes ^{241}Am and ^{243}Am is investigated. For detection of the fission fragments a spark counter was used. Integral yields of both the isomers dependent on the end-point energy of bremsstrahlung γ-quanta were measured. Thresholds of the reactions producing the isomer states are determined and excitation energies for the isomer levels are calculated. The isomeric ratio for ^{240}Am is calculated comparing the fragment yields for the delayed and induced fissions. (auth)

30822 APPARATUS FOR THE PRODUCTION AND FAST SEPARATION OF GASEOUS FISSION PRODUCTS. Lundan, A.; Anttila, K. (Technical Univ., Helsinki). Nucl. Instrum. Methods; 79: 333-40(1970).

A technique suitable for the production of short-lived fission product halogens and rare gases is described. UO_2 targets placed in a methane-filled chamber are irradiated in a neutron flux of 10^{11}n/cm^2·s in the thermal column of a Triga Mk II reactor. Iodine and bromine originating from the fission of ^{235}U are brought to a gaseous phase through hot-atom reactions with methane. After the irradiation the radioactive gas mixture, which contains methyl halogenides, fission product rare gases and methane, is swept out of the reactor by a methane stream and transferred to chemical separation and counting apparatus. Gas transfer times shorter than 2 s can be achieved. The operation of the apparatus is fully automatised. The gamma spectra of the short-lived fission product isotopes produced with the aid of this device were investigated by means of a 20 cm^3 Ge(Li) detector. Three new gamma lines were found. Transitions with energies 144.5 ± 3.2 keV and 1223.0 ± 3.9 keV and half-lives 1.7 ± 0.25 s and 2.2 ± 0.3 s, respectively, are supposed to belong to the isotope ^{92}Kr. A 590.0 ± 0.3 keV transition with half-life 6.9 ± 2.4 s is tentatively assigned to the isotope ^{138}I. A weak line at 1217 ± 2 keV which was previously assigned to ^{137}I was also seen. (auth)

30823 NATURE OF EXCITED STATES OF ^{103}Rh. Begzhanov, R. B.; Sabirov, Kh. S. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 11: 3-7(1970). (In Russian).

Lifetimes of excited states with the energies 93, 536 and 650 keV of ^{103}Rh nucleus were measured by means of a device of slow-fast coincidences. These were found to be: $T_{½}$ (93 keV) ≤ 0.8·10^{-9} sec, $T_{½}$ (536 keV) = (0.68 ± 0.04)·10^{-10} sec, and $T_{½}$ (650 keV) ≤ 0.1·10^{-9} sec. Measurements of the angular correlations in γ emission in the cascades 556–53 and 443–53 keV have shown that the coefficients A_2 and A_4 are as follows: for the first cascade A_2 = ±0.127 ± 0.010 and A_4 = 0.005 ± 0.009, for the second A_2 = +0.136 ± 0.012 and A_4 = 0.022 ± 0.017. Based on the analysis of the results obtained, some assumptions on the nature of excited states of ^{103}Rh are made. (auth)

30824 SUPERHEAVY ELEMENTS: EXPANSION OF THE PERIODIC SYSTEM. Greiner, Walter (Univ., Frankfurt am Main). Umsch. Wiss. Tech.; 69: 365-72(5 Jun 1969). (In German).

Theoretical and technical aspects of transuranium elements are discussed and depicted in ten diagrams. It is suggested that two or three islands of relatively stable superelements may exist around mass numbers 300, and between 400 and 500. Many of these elements are expected to be practically stable for fission but instable against α-decay. Half-life ranges up to 100,000 years may be reached. Eighteen references are given. (H.B.G.)

30825 CUMULATIVE YIELDS IN THE 14 MeV NEUTRON FISSION OF ^{232}Th AND ^{238}U IN THE SYMMETRIC REGION. Gevaert, L. H. (Univ. of Toronto); Jervis, R. E.; Sharma, H. D. Can. J. Chem.; 48: 641-51(15 Feb 1970).

The radiochemical yields of molybdenum-99, ruthenium-103 and -105, palladium-109 and -112, silver-111 and -113, cadmium-115, and tin-121 and -125 formed in the 14-MeV fission of thorium-232 and uranium-238 were determined using a low background Geiger–Müller counter, NaI(Tl) crystal, and Ge(Li) detector. The absolute mass yield for molybdenum-99 was obtained using a copper monitor for neutron flux and for the other nuclides using molybdenum-99 as an internal standard. The mass distribution curves derived from the chain yields, in the symmetric region show the presence of a third peak in thorium-232, and only the familiar two peaks for uranium-238 in the asymmetric region. By comparison of normalized cumulative mass yields from this study with prompt fission yield data, the average number of prompt neutrons emitted from fission fragments was obtained as a function of mass in ^{238}U + n fission. It appears that there are two regions of enhanced neutron emission in the mass range 103–128, and that the heavy fragments emit more neutrons than the light ones. (auth) (Canada)

30826 ANALOGUE RESONANCES OF ODD CADMIUM ISOTOPES. Abramson, E.; Eisenstein, R. A.; Plesser, I.; Vager, Z. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A138: 609-25(1969).

A study of analog resonances by elastic proton scattering from ^{106}Cd, ^{108}Cd, ^{110}Cd, ^{112}Cd, ^{114}Cd, and ^{116}Cd is reported. Resonance parameters were extracted, and spectroscopic factors were derived. The method used for calculating single-particle widths is discussed as are the systematics of the obtained spectroscopic factors. (auth)

30827 ELASTIC AND INELASTIC PROTON SCATTERING FROM ^{124}Te. Rao, M. N.; Stelson, P. H.; Robinson, R. L.; Ford, J. L. C. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A147: 1-11(1970).

Angular distributions of elastically and inelastically scattered 12-MeV protons from ^{124}Te were measured. Parameters of an optical model to fit the observed elastic scattering were obtained. The measured cross sections for the excitation of the one-phonon (2^+ and 3^-) states were compared to the predictions of the DWBA analysis and quadrupole and octupole deformations parameters were extracted. Using these deformation parameters and the same optical-model parameters as used in the DWBA analysis (except for the depth of the absorptive potential), the predictions of the coupled-channel calculations were obtained for the two-phonon as well as the one-phonon states. (auth)

30828 A NOTE ON THE DECAY SCHEME OF 13 d ^{126}I. Singh, B.; Taylor, H. W. (Univ. of Toronto). Nucl. Phys.; A147: 12-18(1970).

The γ radiation emitted by 13-d ^{126}I was studied with Ge(Li) spectrometers and coincidence techniques. The energies (intensities) of the γ rays observed were: 388.6(100), 491.3(6.2), 666.4(94), 754.0(12), 879.7(2.1), 1377.7(0.004), 1420.3(0.89) and 2044.7(0.012) keV. Two previously unreported γ rays at 1377.7 and 2044.7 keV establish a new level in ^{126}Te at 2044.4 ± 0.8 keV. A revised decay scheme is presented and the nature of the new level discussed. (auth)

30829 STRUCTURE OF THE LOW-LYING ENERGY LEVELS OF ^{200}Hg. Beraud, R.; Berkes, I.; Daniere, J.; Haroutunian, R.; Levy, Michele; Marest, G.; Rougny, R. (Univ. de Lyon, Villeurbanne, France). Phys. Rev.; 188: 1958-62(20 Dec 1969).

The decay scheme of ^{200}Tl → ^{200}Hg has been reinvestigated with a Ge(Li) detector. The construction of the level scheme allows the removal of some of the ambiguities of previous investigations. From spectrum and angular-correlation measurements, the spin and parity of the 1029.5-keV third excited level of ^{200}Hg is established as 0^+. The low-energy level scheme of ^{200}Hg is interpreted as due to the perturbation of the vibrational spectrum of bosons by a quadrupole interaction. (auth)

30830 TIMES OF EMISSION OF K X RAYS FROM ^{252}Cf FISSION FRAGMENTS OF KNOWN MASS. Long, A. B.; Wehring, B. W.; Wyman, M. E. (Univ. of Illinois, Urbana). Phys. Rev.; 188: 1948-57(20 Dec 1969).

The measured yield of K x rays emitted from fission fragments of ^{252}Cf is reported as a function of the time after fission for times between 1 and 56 nsec, and as a function of the mass of the fragment emitting the x ray. In the experiment, three-parameter data were recorded event by event. The first and second parameters contained information about the energies of both fission fragments from which it was possible to calculate the mass of each fragment. The third parameter contained a signal that was proportional to the time that elapsed between the detection of one of the fission fragments and the detection of an x ray. The timing data were sorted to yield x-ray timing spectra for fission-fragment mass intervals 4 amu wide. Each timing spectrum was fitted with a function that was derived from folding the prompt-response function of the system into a sum of three exponential decays. This analytical technique permitted the determination of the percent of the total x-ray emissions coming from each of the three half-life groups. These results, in conjunction with the yield data, were then interpreted in terms of fragment excitation states and comparisons were made with previously reported data. (auth)

30831 SINGLE-HOLE STRUCTURE OF ^{207}Pb. Whitten, C. A. Jr.; Stein, Nelson; Holland, G. E.; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30-1)-3223. Phys. Rev.; 188: 1941-7(20 Dec 1969).

The ^{208}Pb(p,d)^{207}Pb reaction was used with 20.00- and 22.00-MeV proton beams from the Yale MP tandem accelerator to study the low-lying neutron-hole levels of ^{207}Pb. The finite-range, nonlocal distorted-wave Born-approximation (DWBA) analyses of the experimental (p,d) angular distributions indicate that the $½^-(3p_{½}^{-1})$ ground state, the $½^-1(2f_{½}^{-1})$ 570-keV level, the $½^-(3p_{½}^{-1})$ 894-keV level, and the $13/2^+(1i_{13/2}^{-1})$ 1634-keV level are almost pure single-neutron-hole levels in the ^{208}Pb core. The $2f_{½}$ neutron-hole strength, and particularly the $1h_{½}$ neutron-hole strength, may be somewhat fragmented, although the $½^-(2f_{½}^{-1})$ 2334-keV level and

the $9/2^-$, $(1h_{9/2}^{-1})$ 3430-keV level represent large fractions of their respective sum-rule neutron-hole strength. No evidence was found for J dependence in the ^{208}Pb(p,d) angular distributions at E_p = 20.00 and 22.00 MeV. (auth)

30832 PROTONS FROM 2.7-GeV PROTONS ON Ag AND Br. King, D. T. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). Phys. Rev.; 188: 1731-4(20 Dec 1969).

The cross section for nonelastic collisions of 2.7-GeV protons in Ag and Br nuclei was determined. Among 3565 such collisions in nuclear emulsions, the tracks of 646 outgoing protons with kinetic energies in the range 80 to 850 MeV were identified by measurements of ionization and multiple Coulomb scattering. The differential cross sections for proton emission were derived and compared with the predictions of Bertini using the Monte Carlo treatment of the intranuclear cascade. Reasonable agreement was found. (auth)

30833 STATISTICAL PROPERTIES OF ^{104}Rh LEVEL PARAMETERS. Ribon, P.; Girard, J.; Trochon, J. (CEN, Saclay, France). Nucl. Phys.; A143: 130-50(1970). (In French).

The interaction of slow neutrons (up to 4 keV) with ^{103}Rh is used to study 273 levels in ^{104}Rh. The experiments (transmission and scattering by time-of-flight method) are described and results given. Statistical properties of the levels and average values are deduced from the parameters of individual levels. The correlation coefficient between radiation width and reduced neutron width is 0.64 ± 0.30. The average radiation width appears to be independent of spin and parity. (auth)

30834 THE LOW-ENERGY LEVEL STRUCTURE OF ^{191}Ir. Malmskog, S. G. (Aktiebolaget Atomenergi, Studsvik, Sweden, Univ. of Stockholm); Berg, V.; Baecklin, A.; Hedin, G. Nucl. Phys.; A143: 160-76(1970).

The decay of ^{191}Pt to ^{191}Ir is investigated using Ge(Li) detectors and a double focusing beta spectrometer. Thirty-five transitions are observed and most of them are placed in a level scheme. Special attention is given to the low energy level band structure. Several multipolarity mixing ratios are determined from L-subshell ratio measurements. Using the delayed coincidence technique the half-life of the 179.05 keV level is measured to 40 ± 12 psec. The low-level decay properties are discussed in terms of the Nilsson model with the inclusion of Coriolis coupling. (auth)

30835 LEVEL STRUCTURE IN ^{193}Ir. Berg, V. (Univ. of Stockholm, Aktiebolaget Atomenergi, Studsvik, Sweden); Malmskog, S. G.; Baecklin, A. Nucl. Phys.; A143: 177-201(1970).

The decay of ^{193}Os is studied using Ge(Li) detectors and a 50 cm $\pi\sqrt{2}$ spectrometer. Multipolarities and E2/M1 mixing ratios are determined for 23 transitions. Half-life measurements applying the delayed coincidence technique give the following mean lives: τ(138.97 keV level) = 108 ± 15 ps and τ(180.17 keV level) = 80^{+4}_{-4} ps. The M1 and E2 transition probabilities obtained are discussed in terms of the core excitation model and the Nilsson model. (auth)

30836 SCATTERING OF 60-MeV ELECTRONS FROM ^{90}Zr. Bellicard, Jean (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France); Leconte, Phillipe; Curtis, Thomas H.; Eisenstein, Robert A.; Madsen, David; Bockelman, Charles. Nucl. Phys.; A143: 213-24(1970).

The rms radius of the charge distribution of ^{90}Zr is measured to be 4.12 ± 0.05 fm by elastic electron scattering. Reduced transition probabilities and transition radii for the 2.18 MeV (2^+), 2.74 MeV (3^-) and 3.84 MeV (2^+) states are deduced from a distorted-wave analysis of inelastic scattering. The results for B(EL↑) are discussed briefly in the light of current theories. (auth)

30837 SEARCH FOR ELEMENT 114 IN LEAD MINERALS VIA NEUTRON-INDUCED FISSION. Wyttenbach, A. (Eidgenoessische Institut fuer Reaktorforschung, Wuerenlinger, Switzerland). Z. Naturforsch.; 25a: 307-8(Feb 1970).

A search was made for neutron-induced fission in three lead minerals (cerussite, wulfenite, and galena), using delayed neutron counting. After irradiation, all minerals showed delayed neutron emission which was suspected to be due to their U content. The minerals were chemically separated, and the delayed neutron emission of the Pb and Tl fractions found not to exceed the background. The variables of the number of delayed neutrons emitted per fission and the fission cross section are considered. The upper limit of [114]/[Pb] is estimated to be 9×10^{-11} and 5×10^{-8} for fission cross sections of 580 and 1 barns, respectively. (D.L.C.)

30838 DIRECTIONAL CORRELATIONS BETWEEN X RAYS AND INTERNAL CONVERSION ELECTRONS IN ^{145}Sm, ^{195}Au, AND ^{203}Hg. Brannan, John Robert. Columbus, Ohio; Ohio State Univ. (1969). 200p.

Thesis.

The existence of directional correlations between x rays and internal conversion electrons was determined by comparing the count rate of electrons that were in coincidence with x rays emitted at 180° relative to the direction of electron emission with the coincidence count rate of emission at 90°. The anisotropy, which is the ratio of the difference of these two rates to the 90° coincidence count rate, was calculated, and it served as a measure of the magnitude of the directional correlation. The isotopes studied were ^{145}Sm, ^{195}Au, and ^{203}Hg, and anisotropies were measured for most of the coincidence combinations of K and L x rays and K- and L-conversion electrons including x ray–x ray pairs. A non-zero directional correlation (anisotropy) was found to exist in the decay of ^{145}Sm between the L x ray and the L-conversion electron. In the decay of ^{195}Au, correlations were found between the K x ray and the K x ray and also between the L x ray and (1) the K x ray, (2) the 84.6-keV L-conversion electron, (3) the 95.1-keV M-conversion electron, and (4) the 115.5-keV L-conversion electron. In the decay of ^{203}Hg, correlations were found to exist between the L x ray and (1) the K x ray, (2) the K-conversion electron, and (3) the L-conversion electron. Within the limits of precision of the experiments, directional correlations were found not to exist in the case of ^{145}Sm decay between the K x ray and (1) the K x ray, (2) the L x ray, and (3) the L-conversion electron. For ^{195}Au correlations were found not to exist between the L x ray and the L x ray and also between the K x ray and (1) the 84.6-keV L-conversion electron, (2) the 95.1-keV M-conversion electron, and (3) the 115.5-keV L-conversion electron. For ^{203}Hg correlations were found not to exist between the K x ray and (1) the K x ray and (2) the K-conversion electron. (Diss. Abstr. Int., B)

30839 TIMES OF EMISSION OF K X RAYS FROM ^{252}Cf FISSION FRAGMENTS OF KNOWN MASS. Long, Alexander Blaikie. Urbana, Ill.; Univ. of Illinois (1969). 154p.

Thesis.

The yield of K X rays emitted from fission fragments of ^{252}Cf is reported as a function of the time after fission and the mass of the fragment emitting the X ray. These X rays are produced as a result of the de-excitation of the fission fragment by the process of internal conversion and their times of emission are characteristic of the lifetimes of the excited states of the fragment nuclei. Three parameter data were recorded event by event in the present experiment. The first and second parameters contained information about the energies of both fission fragments as measured by silicon surface-barrier detectors from which it was possible to calculate the mass of each fragment. The third parameter contained a signal proportional to the time that elapsed between the detection of one of the fission fragments and the detection of an X ray by a 56 AVP phototube. Only X rays emitted between 1 and 56 nanoseconds after fission were recorded by the system. The timing data were sorted to yield X-ray timing spectra for fission fragment mass intervals 4 amu wide, and sorted separately for the light and heavy fragments to yield X-ray timing spectra for total fission fragment kinetic energy intervals 5 MeV wide. The timing data were also combined to obtain the X-ray yields as a function of fission fragment mass. The timing spectra were fitted with a function derived from folding the prompt response function of the system into a sum of three exponential decays. This analytical technique permitted the determination of the percent of the total X-ray emissions coming from each of the three different half-life groups. These results in conjunction with the yield data were then interpreted in terms of fragment excitation states. Comparisons were made with previously reported data for X-ray emission from ^{252}Cf and ^{238}U. (Diss. Abstr. Int., B)

30840 THE YIELDS OF ^{133}Cs(gamma,xn) AND ^{133}Cs(gamma, 2pxn) REACTIONS WITH 150, 200, AND 250 MeV BREMSSTRAHLUNG. Kato, Toyoaki; Tsai, Hui-tuh; Oka, Yoshinaga (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap.; 43: 576(Feb 1970).

The yields of the reactions (γ,n), (γ,4n), (γ,6n), (γ,2p), (γ,2pn), (γ,2p5n), (γ, 2p7n), (γ, 2p8n), (γ,2p10n), and (γ,2p11n) in ^{133}Cs, determined by the residual activity method in order to investigate the reactivity of high-energy bremsstrahlung photons with nuclei in heavy mass region, are discussed. (L.W.A.)

30841 ENERGY DISTRIBUTION OF SLOWING DOWN FISSION FRAGMENTS. Solov'ev, S. M.; Eismont, V. P. At. Energ. (USSR); 27: 293-6(Oct 1969). (In Russian).

In the last few years semiconductor detectors have been used to measure energies of slowing fission fragments. However, all investigations have been restricted to the measurements of mean losses (without separation of heavy and light fragments) or were conducted in the energy above 20 MeV. The kinetic energy spectra (up to energies about 5 MeV) fragments from ^{235}U thermal neutron induced fission were measured with semiconductor detectors

after the fragments penetrated through the air layer of known thickness. The dependencies of mean energies and dispersion of energies of light and heavy fragments on the range of slowing in air were found. It was established that dispersion of energy distribution of light and heavy fragments decreases to the end of the range by a factor of 20. The pattern of changes in dispersion in the initial part of range is different for light and heavy fragments. The experimental range-energy relations for mean light and heavy fragments are compared with calculations on the basis of unified theory of heavy ion slowing. It is noted that the theory gives values of fragments energy losses with the accuracy of not more than 20%. (auth)

30842 CUMULATIVE YIELDS IN THE PHOTOFISSION OF ^{232}Th AND ^{238}U IN THE SYMMETRIC REGION. Gevaert, L. H. (Univ. of Toronto); Jervis, R. E.; Subbarao, S. C.; Sharma, H. D. Can. J. Phys.; 48: 652-6(15 Feb 1970).

Fission mass yields for molybdenum-99, ruthenium-103 and -105, palladium-109 and -112, silver-111, cadmium-115, and tin-121 and -125 in the 25 MeV bremsstrahlung beam fission of thorium-232 and uranium-238 were determined using radiochemical methods. The mass-yield curve for thorium-232 shows a pronounced third peak in the symmetric region, contrary to the results of Hiller and Martin with 69 MeV brehmsstrahlung. In the case of uranium-238, the curve is flat between mass numbers 111 to 121 in contrast to the 14-MeV neutron fission of the nuclide which shows a valley in this region. (auth) (Canada)

30843 PRODUCTION OF TRITIUM IN Al, Sn, Pb, AND Bi BY HIGH ENERGY PROTONS. Mekhedov, B. N.; Mekhedov, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 708-10(Apr 1970). (In Russian).

The cross section of the tritium production in Al, Sn, Pb, and Bi in the proton energy region 0.15–0.66 and 3–10 GeV, is measured. The cross sections obtained are in reasonable agreement with previous data. (auth)

30844 ONE MORE SOURCE OF THE ADDITIONAL STRUCTURE OF DIPOLE RESONANCES. Zhivopistsev, F. A.; El Nagar, N.; Shitikova, K. V.; Yudin, N. P.; Akbary, M. Y. (Moscow State Univ.). Phys. Lett.; 31B: 347-9(16 Mar 1970).

The structure arising from the coupling of 3^- states with particle-hole states is calculated for ^{90}Zr and ^{208}Pb. (auth)

30845 TEMPERATURE OF Dy NUCLEI EXCITED TO 40 TO 150 MeV. Alexander, John M.; Natowitz, J. B. (State Univ. of New York, Stony Brook). Phys. Rev.; 188: 1842-50(20 Dec 1969).

From the systematics of cross sections and neutron energies for (HI, xn) reactions, the average energy of the first emitted neutron has been obtained. These average energies reflect the nuclear temperature or level-density parameter. Average photon energies are also obtained and compared to calculated values of the lowest-lying levels for each spin. Reactions are considered which involve the emission of 3–11 neutrons from compound systems of 40–150 MeV and average spin 15–80. New experimental data are presented for the reactions ^{148}Nd(^{12}C, 5n)^{155}Dy, ^{150}Nd(^{12}C, 5n)^{157}Dy, and ^{150}Nd(^{12}C, 7n)^{155}Dy. (auth)

30846 FAST NEUTRON SCATTERING CROSS SECTIONS OF ELEMENTAL Sm, Gd, AND Hf. Sherwood, George Leslie Jr. Evanston, Ill.; Northwestern Univ. (1969). 150p.

Thesis.

Inelastic and elastic scattering cross sections of elemental Sm, Gd and Hf were obtained using a pulsed-beam, fast-neutron time-of-flight technique. Argonne National Laboratory facilities, consisting of a 3 MV pulsed and bunched Van de Graaff accelerator and associated time-of-flight equipment, were used in the experimental studies. Theoretical analysis was made using the optical model with both spherical and deformed potentials and the statistical theory of Hauser and Feshbach. (Diss. Abstr. Int., B)

30847 LEVEL STRUCTURE AND BAND MIXING IN ^{232}U. Varnell, L. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Nucl. Phys.; A144: 429-40(1970).

The energy and relative intensities of gamma transitions in ^{232}U following the radioactive decay of 1.3 d ^{232}Pa were measured with a Ge(Li) spectrometer and with the Caltech bent crystal spectrometer. Relative intensities of internal conversion electrons were measured with a Si(Li) detector. Coincidence measurements were also made using NaI and Ge(Li) detectors. The following rotational bandheads were established: octupole vibrational band ($K^\pi = 0^-$ at 563.2 keV), β-band (0^+ at 691.3 keV), γ-band (2^+ at 866.7 keV) and two negative parity bands (2^- at 1016.8 keV) and (1^-? at 1132.4 keV). Transitions from the γ-band to the ground state band are in good agreement with a single parameter band mixing model, with $z_2 = 0.025 \pm 0.005$. However, the relative B(E2) for the $2_\gamma - 0_\beta$ transition is five times that for the $2_\gamma - 0_{g.s.}$ transition. Good agreement with predictions of the rotational model for the E1 transitions from the octupole 0^- band to the ground state band was found. There is evidence for strong mixing of the proposed negative parity bands at higher energy. (auth)

30848 MAGNETIC MOMENTS OF EXCITED STATES IN ^{190}Os, ^{192}Os, AND ^{192}Pt. Levanoni, M.; Zawislak, F. C.; Cook, D. D. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Nucl. Phys.; A144: 369-83(1970).

The $\gamma-\gamma$ perturbed angular correlation technique and the strong hyperfine magnetic fields experienced by osmium and platinum impurities embedded in an Fe lattice host, were used in obtaining the following results: ^{190}Os: $\mu_{2^+} = 0.54 \pm 0.06$ n.m., $\mu_{4^+} = 0.88 \pm 0.48$ n.m.; ^{192}Os: $\mu_{2^+} = 0.56 \pm 0.08$ n.m.; ^{192}Pt: $\mu_{2^+} = 0.56 \pm 0.06$ n.m., $\mu_{2^{+\prime}} = 0.62 \pm 0.14$ n.m. All but one of the measurements were performed with two high-resolution Ge(Li) detectors. The 4^+ state in ^{190}OS was investigated with two NaI spectrometers. (auth)

30849 ANGULAR DISTRIBUTIONS OF ^{137m}Ce AND ^{137g}Ce FROM THE ^{134}Ba(α,n) REACTION. Swanson, D. G.; Porile, N. T. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; A144: 355-68(1970).

The angular distributions of ^{137m}Ce and ^{137g}Ce nuclei formed in the ^{134}Ba(α,n) reaction were measured at three different energies in the range between 18 and 25 MeV. The results were compared with a spin-dependent statistical-model calculation. Satisfactory agreement was obtained between theory and experiment at small angles. At large angles the calculated differential cross section was smaller than expected from the experimental data. The discrepancy can be attributed to a small contribution from a direct interaction mechanism. Average properties of the angular distributions were used to obtain the average values of the neutron and photon energies and the difference in the values obtained for the two isomers was interpreted in terms of angular momentum effects. An angular distribution calculation for a hypothetical nucleus suggests that it may be possible to observe striking differences in the angular distribution of (α,n) reaction isomers due to spin fractionation. (auth)

30850 AVERAGE RANGES, CROSS SECTIONS, AND ISOMER RATIOS FOR THE ^{134}Ba(α,n)^{137m,g}Ce REACTION. Swanson, D. G.; Porile, N. T. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; A144: 344-54(1970).

Excitation functions, isomer ratios and average recoil ranges were determined for the ^{134}Ba(α,n) reaction over the energy range from 15 to 28 MeV. The average ranges are compared with values predicted by Lindhard, Scharff and Schiøtt on the assumption of compound nucleus formation and the experimental isomer ratios and excitation functions with the results of a spin-dependent statistical model calculation. These comparisons suggest that both compound nuclear and direct processes contribute in the above energy range. (auth)

30851 STUDY OF LOW-LYING STATES IN CADMIUM ISOTOPES BY (p,p'γ) ANGULAR CORRELATION VIA ANALOGUE RESONANCES. Abramson, E.; Eisenstein, R. A.; Plesser, I.; Vager, Z.; Wurm, J. P. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A144: 321-43(1970).

Correlation measurements of inelastic protons, from even cadmium isotopes via analog resonances, and $2^+ \rightarrow 0^+$ γ-rays are reported. The analysis takes into account compound enhancement and yields partial decay amplitudes. The latter are interpreted as amplitudes in a fractional parentage expansion of the parent analog states. (auth)

30852 DECAY OF THE γ-VIBRATIONAL BAND IN ^{250}Cf. Stelson, P. H. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.); Lide, R. W.; Bingham, C. R. Nucl. Phys.; A144: 254-60(1970).

Measurements were made of the energies and intensities of the transitions which de-excite the γ-vibrational band in ^{250}Cf following beta decay of ^{250}Bk. The use of a Ge(Li) γ-ray detector with accurately calibrated relative efficiency permitted the determination of branching ratios to good precision. These branching ratios were analyzed in terms of the band mixing parameter, Z. It was found that all the B(E2) ratios are consistent with a single Z-value of 0.0175 ± 0.0020. (auth)

30853 FRAGMENTATION OF THE OCTUPOLE STRENGTH IN ^{205}Tl(p,p')^{205}Tl. Glashausser, C.; Hendrie, D. L.; Loiseaux, J. M.; McClatchie, E. A. (Univ. of California, Berkeley). Phys. Lett.: 31B: 289-91(2 Mar 1970)

In addition to the octupole transitions to the apparent weak-coupling doublet [$3s_{\frac{1}{2}}^{-1}$, ^{206}Pb 3^-] at 2.62–2.71 MeV, three other strong octupole transitions to nearby states are observed in the inelastic scattering of 20-MeV protons from ^{205}Tl. Two of these extra states, at 3.21 and 3.26 MeV, may arise from the [$2d_{\frac{5}{2}}^{-1}$, ^{206}Pb 3^-] configuration. It is not likely that the other transition

(2.48 MeV) can be described by the simple weak-coupling model. (auth)

30854 (t,p)-REACTION STUDIES OF THE TRANSITIONAL NUCLEI ^{150}Nd AND ^{152}Nd. Chapman, R. (Atomic Energy Research Establishment, Harwell, Eng.); McLatchie, W.; Kitching, J. E. Phys. Lett.; 31B: 292-4(2 Mar 1970).

The 0^+ states observed in the reactions ^{148}Nd(t,p)^{150}Nd and ^{150}Nd(t,p)^{152}Nd are reported and discussed. Their properties suggest significant differences between the samarium and neodymium at the onset of nuclear deformation. (auth)

30855 ISOTOPE SHIFT OF ^{151}Eu, ^{152}Eu, ^{153}Eu, AND ^{154}Eu. THE SIGNS OF THE NUCLEAR DIPOLE MOMENT OF ^{152}Eu AND THE NUCLEAR QUADRUPOLE MOMENTS OF THE ^{152}Eu AND ^{154}Eu. Heinecke, P.; Steudel, A.; Walther, H. (Technische Univ., Hanover). Phys. Lett.; 31B: 295-6(2 Mar 1970).

The isotope shift of ^{151}Eu, ^{152}Eu, ^{153}Eu and ^{154}Eu was measured. Furthermore the hyperfine splitting of ^{152}Eu was investigated. From the sign of this splitting and earlier experimental results, the signs of $\mu(^{152}$Eu), $Q(^{152}$Eu) and $Q(^{154}$Eu) are derived. (auth)

30856 ISOBARIC ANALOGUE STATE OF THE ^{199}Au GROUND STATE AND β DECAY OF THE LATTER. Bogdan, D.; Carjan, N.; Piticu, I. (Inst. for Atomic Physics, Bucharest). Phys. Lett.; 31B: 280-2(2 Mar 1970).

Using the relation between the form factors $^{V}F^{(n)}_{11}$, $^{V}F^{(n)}_{01}$ and the E_γ of the γ ray from the isobaric analogue state of the ^{199}Au ground state, it is shown that the correction matrix elements are very important for the β decay ^{199}Au($^3/_2^+$) → ^{199}Hg($^1/_2^-$). (auth)

30857 NEUTRON EXCESS DISTRIBUTION IN ^{208}Pb. Sinha, B. C.; Edwards, V. R. W. (King's Coll., London). Phys. Lett.; 31B: 273-6(2 Mar 1970).

It is shown that adding a derivative Saxon Woods term to the real part of the optical potential to represent the symmetry potential arising from the excess neutrons greatly improves the fits to the elastic scattering of 30.3, 40.0 and 61.4 MeV protons from ^{208}Pb. The depth and geometry of the best fit derivative term are found to be consistent with: (i) the cross sections for the ^{208}Pb(p,n)^{208}Bi reaction at 30 and 50 MeV; (ii) the Coulomb displacement energy of ^{208}Pb and (iii) the strength of the isospin dependent component of the effective two nucleon force. (auth)

30858 GAMMA RAYS FOLLOWING NEUTRON INELASTIC SCATTERING IN ^{197}Au. Nelson III, Joseph Alvin. New Orleans; Tulane Univ. (1969). 56p.

Thesis.

A ring scattering geometry was used to observe gamma-rays following neutron inelastic scattering in ^{197}Au at twenty neutron energies from 225 to 2200 keV using a 30 cc Ge(Li) detector. The proton beam of a 3-MV Van de Graaff accelerator was used with a tritiated-titanium target to obtain neutrons from the ^{3}H(p,n)^{3}He reaction. A carbon scattering ring was used to obtain background information. The full energy peaks of gamma-rays attributed to neutron inelastic scattering in ^{197}Au were used with corrections for gamma-ray attenuation in the ring scatterer and efficiency of the Ge(Li) detector to determine excitation functions proportional to the production cross sections. An Fe scattering ring was used to observe the 845-keV gamma-ray from the ^{56}Fe(n,n'γ) reaction for use in conversion of excitation functions to absolute cross sections. A total of 57 gamma-rays were observed, of which 19 were assigned levels at 77, 268, 279, 502, 548, 736, 856, 890, 937, 1045, 1152, 1220 and 1243 keV. (Diss. Abstr.)

30859 ISOBARIC ANALOG RESONANCES IN ^{90,92}Zr(p,p'). Kent, James Joseph. Austin, Tex.; Univ. of Texas (1969). 99p.

Thesis.

Excitation functions were measured for elastic and inelastic scattering of protons to several low-lying final states of ^{90}Zr and ^{92}Zr. The incident protons were in the energy range from 6.0 to 10.0 MeV, and the excitation curves were measured in steps of approximately 15 keV. The excitation functions displayed resonances in all channels which were interpreted as the isobaric analogs of low-lying states in the target plus neutron system. Angular distributions were measured on these prominent resonances. The elastic scattering excitation functions were analyzed using Weidenmueller's theory. This consists of a modified Breit-Wigner single resonance term interfering with a background generated by the optical model. The optical parameters and the resonance parameters were adjusted to give the best agreement with the measured excitation functions at several angles. In this manner the total and partial widths of each of the resonances were determined. In order to extract the spectroscopic factors of these resonances, the appropriately defined single-particle widths were calculated. Using the partial and total widths extracted from the elastic scattering data, the inelastic scattering in various channels was analyzed using Weidenmueller's resonance term. In this manner the partial width in the inelastic channel for each resonance was extracted. To obtain a spectroscopic factor for these states, the measured widths were compared with those calculated as in the elastic case, except that they were calculated at the channel energy of the inelastically scattered proton. It was also of particular interest in these experiments to determine whether any states in the parent nuclei were well represented as a single neutron coupled to an excited state of the target. Several such "weak-coupling" states were found based on the 0^+ first excited states of each of the target nuclei. Angular distributions measured on these resonances identified their spins to be that implied by the weak-coupling scheme. (Diss. Abstr.)

30860 STUDIES OF TWO-STEP GAMMA-RAY CASCADES IN NEUTRON-CAPTURE REACTIONS IN A BARIUM TARGET. Lussie, William Gordon. Urbana, Ill.; Univ. of Illinois (1969). 147p.

Thesis.

The relative intensities of two-step gamma-ray cascades in ^{136}Ba, ^{138}Ba, and ^{139}Ba were measured using a sum-coincidence spectrometer. The source of gamma rays was produced by irradiation of a barium sample containing the naturally occurring isotopic ratio in an external neutron beam. Only one two-step transition was observed in ^{136}Ba, namely, the 8.41 – 0.818-MeV cascade through the first excited level. The apparent lack of two-step cascades in this isotope may be attributed to the poor efficiency of the sum-coincidence spectrometer for detecting cascades having total energy of 9.23 MeV. Eight cascades were detected in ^{139}Ba. The emission orders of four of these cascades were determined by comparison of levels reported in studies of the β^- decay of ^{139}Cs. The intermediate levels of these cascades were at excitation energies of 1.438, 2.21, 2.63, and 3.34 MeV, and the relative intensities of the cascades were 1.00, 0.72, 0.58, and 0.41, respectively. The emission orders for the remaining four cascades are unknown. The energies of the components of the cascades were 2.05-6.57 MeV, 2.83-5.74 MeV, 3.05-5.57 MeV, and 3.70-4.98 MeV, and their relative intensities were 0.45, 0.46, 0.62, and 0.99, respectively. Seven two-step cascades were observed in ^{139}Ba. The emission order of each component of the cascades was assigned to agree with levels reported in studies of β^- decay of ^{139}Cs and of the ^{138}Ba(d,p)^{139} reaction. The intermediate energy levels of the two-step transitions were 0.627, 1.08, 1.28, 1.71, 1.91, 2.14, and 2.47 MeV. The relative intensities of the cascades were 1.00, 0.42, 0.19, 0.14, 0.43, 0.07, and 0.07, respectively. Spin and parity assignments for the various intermediate levels observed in ^{136}Ba, ^{138}Ba, and ^{139}Ba are proposed. (Diss. Abstr.)

30861 BETA AND GAMMA VIBRATIONAL BANDS IN DEFORMED NUCLEI. Varnell, Larry Shelton. Pasadena, Calif.; California Inst. of Tech. (1969). 119p.

Thesis.

Energies and relative intensities of gamma transitions in ^{152}Sm, ^{152}Gd, ^{154}Gd, ^{166}Er, and ^{232}U following radioactive decay were measured with a Ge(Li) spectrometer. A peak fitting program was developed to determine gamma ray energies and relative intensities with precision sufficient to give a meaningful test of nuclear models. Several previously unobserved gamma rays were placed in the nuclear level schemes. Particular attention was paid to transitions from the beta and gamma vibrational bands, since the gamma ray branching ratios are sensitive tests of configuration mixing in the nuclear levels. As the reduced branching ratios depend on the multipolarity of the gamma transitions, experiments were performed to measure multipole mixing ratios for transitions from the gamma vibrational band. In ^{154}Gd, angular correlation experiments showed that transitions from the gamma band to the ground state band were predominantly electric quadrupole, in agreement with the rotational model. In ^{232}U, the internal conversion spectrum was studied with a Si(Li) spectrometer constructed for electron spectroscopy. The strength of electric monopole transitions and the multipolarity of some gamma transitions were determined from the measured relative electron intensities. The results of the experiments were compared with the rotational model and several microscopic models. Relative B(E2) strengths for transitions from the gamma band in ^{232}U and ^{166}Er are in good agreement with a single parameter band mixing model, with values of z_2 = 0.025(10) and 0.046(2), respectively. Neither the beta nor the gamma band transition strengths in ^{152}Sm and ^{154}Gd can be accounted for by a single parameter theory, nor can agreement be found by considering the large mixing found between the beta and gamma bands. The relative B(E2) strength for transitions from the gamma band to the beta band in ^{232}U is found to be five times greater than the

strength to the ground state band, indicating collective transitions with strength approximately 15 single particle units. (Diss. Abstr.)

30862 GAMMA RADIATION OF ^{193}Au. Plajner, Z.; Frana, J.; Rezanka, I.; Spalek, A.; Fiser, M.; Vobecky, M. (Inst. of Nuclear Research, Rez, Czech.). Czech. J. Phys.; 20: 132-8 (1970).

The gamma-radiation of ^{193}Au was studied by means of a Ge(Li) semiconductor detector. In addition to the transitions observed by Svahn et al. (Z. Physik 210(1968), 466), 21 new transitions were found. With the use of the relative conversion line intensities from the above reference and the γ-ray intensities of this work, a number of internal conversion coefficients α_K were determined. The multipolarities of the transitions were deduced from a comparison of the experimental and theoretical α_K-values. Some additions to the ^{193}Au decay scheme were made on the basis of new experimental results. (auth)

30863 DETERMINATION OF THE NUCLEAR QUADRUPOLE MOMENT RATIO OF ^{155}Gd/^{157}Gd BY ELECTRON PARAMAGNETIC RESONANCE. Ranon, U.; Stamires, D. N. (McDonnell Douglas Corp., Huntington Beach, Calif.). Chem. Phys. Lett.; 5: 221-5 (1 Apr 1970).

The ratio of the nuclear quadrupole moments of ^{155}Gd and ^{157}Gd was determined from the EPR spectrum of Gd^{3+} in a YPO_4 single crystal. The value $^{155}Q/^{157}Q = 0.94 \pm 0.01$ differs from previously reported ratios. The EPR spectrum is rather unusual in that the quadrupole interaction dominates over the hyperfine interaction. For H perpendicular to the c axis, the overall hyperfine splitting is linear in the quadrupole interaction. (auth)

30864 RATIO OF ^{111}Pd ISOMERS FORMED IN CHARGED-PARTICLE AND PHOTON-INDUCED FISSION OF SEVERAL HEAVY NUCLIDES. Aumann, D. C.; Gindler, J. E. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem.; 32: 731-44(Mar 1970).

Cumulative yield isomeric ratios $(\sigma_m/\sigma_g)_c$ of ^{111}Pd were measured in the fission of ^{230}Th, ^{232}Th, and ^{236}U by helium ions of various energies. The data show that the ratio increases with energy. The angular distribution of the ^{111}Pd fission products indicates a maximum at 180° to the beam direction and a minimum at 90°. The isomeric ratio did not vary with angle within the accuracy of the experiment. Measurements of $(\sigma_m/\sigma_g)_c$ in the photofission of ^{232}Th, ^{238}U, ^{236}U, ^{235}U, ^{234}U and ^{233}U showed a sharp increase with the fission parameter Z^2/A. Independent yield isomeric ratios were calculated from the measured ratios by applying the results of various charge distribution studies reported in the literature. These calculated ratios suggest that there is little correlation between the initial angular momentum of the compound nucleus and the isomeric ratio of the fission product. (auth) (UK)

30865 (n,α) REACTIONS ON Te ISOTOPES AT 14 MeV. Jurcevic, M.; Kulisic, P.; Tudoric-Ghemo, J. (Ruder Boskovic Inst., Zagreb). Fizika (Zagreb); 2: 27-35(1 Jan 1970).

Energy spectra of alpha particles from (n,α) reactions on Te isotopes were measured at an angle of 0°. The characteristic features of all spectra could be explained in terms of a direct process only. The structures of all energy spectra are in a certain correspondence with the single neutron level densities of the residual nuclei. The probabilities of alpha clustering on the surface of the target nuclei were estimated assuming a knock-out mechanism for the (n,α) reaction. (auth)

Nuclear Theory

Refer also to abstracts 29558, 29565, 30467, 30472, 30532, 30668, 30742, 30760, and 30761.

30866 (AAEC/TM-520) GUNYA: CODE FOR GENERATING NEUTRON CROSS SECTIONS. Ferguson, H. D. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nov 1969. 42p. Dep. CFSTI (U. S. Sales Only).

A description is given of GUNYA, a computer code for the preparation of group-averaged neutron cross sections for the six reactions (n,γ), (n,fiss), (n,abs), (n,nubar-fiss), (n,trans), (n,2n) as well as resonance shielding parameters, in a form suitable for use in conjunction with GYMEA, a neutronics code in use by the A.A.E.C. The data requirements and the single-level resolved and statistical resonance theory employed are described. Point cross sections can be averaged over an integrated fission and slowing down spectrum. Cross sections and shielding parameters can be produced for both single nuclides and natural elements. An unlimited number of nuclides/natural elements can be processed in a single run and a comprehensive range of options allows flexibility of input, execution and output. The code is written in FORTRAN IV and is intended for an IBM 360. It uses approximately 200 K bytes of main storage (1 byte = 8 binary bits) but this can be considerably reduced by altering DIMENSION statements. (Australia)

30867 (CEA-R-3960) TWO-BODY NUCLEAR INTERACTION CURRENTS. Chemtob, Marc (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1970. 138p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, France.

A systematic study is made of the role played by meson exchange currents on the electromagnetic properties of nuclei. The description of the non-additive (two-body) part of the electromagnetic interaction is based on a non-covariant formalism using the expansion of the field-theoretic S-matrix in the interaction representation. General expressions for the exchange currents associated to the processes involving the exchange of one pion as well as the exchange of the heavy mesons η, ρ, and ω, are derived. The multiple scattering corrections to the one-pion-exchange process are also examined with the introduction of a radiative vertex representing the full pion photoproduction amplitude by a single nucleon. The predictions of this model are then examined in three main applications. The first application is devoted to an analysis of the exchange effect on the static dipole magnetic moment of odd-mass-nuclei with jj closed-shells plus (or minus) one nucleon, described within the framework of the pure spherical shell model. The exchange correction is generally small in magnitude; its effect is a translation of both Schmidt lines, upwards for odd-proton nuclei and downwards for odd-neutron nuclei. In the second application the role of exchange currents is investigated in the electron scattering excitation of isospin 1 states of ^{12}C lying above 14 MeV. The form factors are calculated with wave functions of the single particle-hole model and compared with data for momentum transfers extending up to 700 MeV/c. The exchange correction is small for low values of the transfer but grows substantially as the transfer increases beyond 500 MeV/c. The effect always leads to an increase of the form factors with a similar dependence on transfer as the one-body form factors. The last application deals with the anomaly in the magnetic moments of the mirror nuclei ^{3}He and ^{3}H. The exchange correction is only calculated for the dominant space-symmetric state $^2S_{\frac{1}{2}}$ and its dependence on short-range correlations is examined by introducing a Jastrow factor in the radial wave functions. A positive sign correction is obtained for the isoscalar moment. The contribution coming from three body exchange currents should not be neglected here. (France)

30868 (COO-1120-94) COMPARISON OF ASYMMETRIC SHAPES FOR DEFORMED NEGATIVE PARITY STATES IN HEAVY EVEN NUCLEI. Davidson, M. G. (Kansas Univ., Lawrence. Nuclear Physics Lab.). [1969]. Contract AT-(11-1)-1120. 19p. Dep. CFSTI.

Asymmetric collective models with pure quadrupole, pure octupole and mixed quadrupole plus octupole shapes are developed for negative parity states in deformed even nuclei in an effort to determine whether the other shapes offer as good a fit to data as the octupole shape usually assumed. The comparison is made of the energy levels and E2 branching ratios of ^{228}Th, ^{232}U, and ^{234}U. It is found that while there are some differences between the models, no clear distinction can be made with existing data. (auth)

30869 (JINR-P4-5003) THE EFFECT OF THE SPIN FORCE ON THE RATE OF ALLOWED G-T β-DECAY IN DEFORMED NUCLEI. Gabrakov, S. I.; Kuliev, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 10p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The effect of the charge-exchange spin-spin interaction on the rate of allowed Gamow–Teller β-decay in odd-mass nuclei is investigated in the framework of TDA. The observed retardation of the β-decay can be explained by such an interaction. The main part of the transition strength is expected to be distributed among high-energy excitations. (auth)

30870 (LA-4379) MODEL FOR THE OPTICAL POTENTIAL OF COMPOSITE PARTICLES. Keaton, P. W. Jr.; Aufdembrink, E.; Veeser, L. R. (Los Alamos Scientific Lab., N. Mex.). Feb 1970. Contract W-7405-eng-36. 64p. Dep. CFSTI.

A model for optical potentials of composite particles is studied. Individual nucleon optical potentials are averaged over the internal motion of deuterons and tritons (or ^{3}He) with realistic wave functions. Analytic expressions are developed for form factors predicted. Results of some specific calculations with the model are presented. (auth)

30871 (MIT-2098-593) NUCLEAR STRUCTURE WITH REALISTIC INTERACTIONS: A SURVEY OF METHODS AND RECENT RESULTS. Baranger, M. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Oct 1969. Contract AT(30-1)-2098. 51p. (CONF-691033-1). Dep. CFSTI.

From 8th Eastern Theoretical Physics Conference, Syracuse, N. Y.

Realistic two-nucleon interactions are mentioned, and the methods of solution are discussed. The methods included are Feynman diagrams, Brueckner's use of the T matrix and the G matrix, the Goldstone expansion, the BBP theorem, particle spectrum and 3-body diagrams, Brueckner-Hartree-Fock calculations, shell model calculations, and folded diagrams. The results of these methods are discussed. (L.W.A.)

30872 (RT/FI-(69)29) SURF: A FORTRAN PROGRAMME FOR THE COUPLED-CHANNEL CALCULATION OF THE PHOTOREACTION CROSS-SECTIONS IN THE ONE PARTICLE-ONE HOLE CONTINUUM APPROXIMATION. Fabbri, F.; Marangoni, M.; Saruis, A. M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 7 Jun 1969. 38p. Dep. CFSTI (U. S. Sales Only).

The description of the SURF programme written for an IBM 7094 computer in FORTRAN IV language is given. The program calculates the dipole photoreaction cross sections of doubly closed-shell nuclei in the one-particle-one-hole continuum approximation. (auth)

30873 (RT/FI-(69)39) MATHEMATICAL REPRESENTATION OF THE HARD CORE IN THE HAMILTONIAN FORMALISM. Palumbo, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 23 Sep 1969. 13p. Dep. CFSTI (U. S. Sales Only).

The hard core is replaced by a singular surface potential. This replacement does not change the eigenvalues nor the eigenfunctions outside and on the boundary of the cores. In general the eigenfunctions do not vanish inside the cores. If the admissible solutions are restricted to twice continuously differentiable functions (on the boundary of cores), the surface potential plus an appropriate soft core ensure the vanishing of the wave functions inside the cores. (auth)

30874 DELAYED NEUTRON EMISSION, THEORY, AND PRECURSOR SYSTEMATICS. Jahnsen, T.; Pappas, A. C.; Tunaal, T. (Univ. of Oslo). pp 35-59 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI/PUB-176; CONF-670424.

Information on the properties of observed delayed neutron precursor and emitters is reviewed. As far as possible, emphasis is laid on charge, mass, half-life, β-energetics, neutron-branching, levels, spin and neutron energy spectra. The theory of delayed neutron emission given by Bohr and Wheeler and later refined is presented and analysed with respect to its potentialities and limitations. Even if the theory gives a good general picture of the process itself, it has not been possible to develop it to such detail as would be necessary for satisfactory delayed neutron precursor systematics. Consequently, the systematics which are available today are based mainly on energetics as criteria, and suggest a wide range (in charge and mass) of precursors, much wider than anticipated, earlier or even now, from those that have already been identified. Nevertheless systematics have their use in a search for precursors and have in recent years resulted in a substantial increase in the member of known species. The process is analyzed step by step (i.e., matrix element, Fermi function, level density, spin distribution, "the energy and the angular momentum paths", and neutron-to-total width). Improvements are suggested that would give rise to a more realistic treatment, and outlines are given for guiding future work. Emphasis is put on that experimental and theoretical information which must be obtained before a satisfactory and advanced theoretical treatment can be obtained. Some attempts made along these lines are presented. Their importance in the estimate of P_n values and shapes of neutron spectra are shown and discussed. For the latter the more different factors (i.e., $|M|^2$, $\omega(E,J)$, Γ_n/Γ_{tot}, J, π, levels, etc.) are considered, the more evidence is obtained for a "piling up" of the neutron spectrum towards low energies. Finally the importance is stressed of detailed delayed neutron studies for considering nuclear structure phenomena. (auth)

30875 INELASTIC ELECTRON SCATTERING AND NUCLEAR STRUCTURE. Henley, E. M.; Halpern, I. Comments Nucl. Particle Phys.; 3: 155-60(Sep-Oct 1969).

Inelastic scattering is discussed and is shown to be a powerful probe of regions of excitation for which $w \ll |q|$, where q is momentum and w is electron energy loss. The scattering of 200 MeV electrons from ^{12}C is discussed as an example. (L.W.A.)

30876 DYNAMICS OF THE SHELL-MODEL POTENTIAL. Brown, G. E. Comments Nucl. Particle Phys.; 3: 136-40(Sep-Oct 1969).

Analog resonances and the effect of isobaric spin mixing are discussed. "Wigner cusps" are briefly mentioned. (L.W.A.)

30877 ANALOGS AND THE RESONANCE RENAISSANCE. Macfarlane, M. H.; Schiffer, J. P. Comments Nucl. Particle Phys.; 3: 141-6(Sep-Oct 1969).

The unification of static well fitting and Hartree-Fock or Brueckner calculations of shell-model potentials via rearrangement is discussed. The findings of Bertsch and Kuo, who used an exclusion principle correction, are presented. Their results indicate that spectroscopic factors should not be larger than .75 for ^{208}Pb, and spectroscopic factors of the order of unity for "single-particle" levels in the Pb region are deemed suspect. (L.W.A.)

30878 ROTONS IN NUCLEAR THEORY. Mikhailov, I. N.; Nadjakov, E. (Joint Inst. for Nuclear Research, Dubna, USSR. Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 22: 1221-4(1969).

A method, which introduces roton operators, to describe nuclear rotation as a first step toward a unified microscopic theory of collective motion is described. A three-dimensional microscopic theory of nuclear rotation, taking interaction and three-D corrections into account, is achieved for the general case. (L.W.A.)

30879 DETERMINATION OF PHOTODISINTEGRATION CROSS SECTIONS INDEPENDENT OF DETECTOR EFFICIENCY AND PHOTON SPECTRUM. Sherman, N. K. (National Research Council of Canada, Ottawa). Nucl. Instrum. Methods; 79: 197-202(1970).

For a nucleus of mass number A whose binding energy for a particle of mass X exceeds that of the nucleus with mass $S \approx 2X$, the differential cross section $\sigma_A(\gamma,X)$ can be obtained at one photon energy when neither the detector efficiency nor the photon energy spectrum is known, provided that the cross section $\sigma_s(\gamma,X)$ is known. For example, if X is a nucleon, S is the deuteron, and if X is a triton, S is ^6Li. At one specific energy the detector efficiencies and photon fluxes will cancel in the ratio of the counting rates. If the relative detector efficiency and spectral shape of the photon beam are known, the comparison sets the absolute cross section scale over an extended energy region. Where efficiency and number of photons per interval are both thought to be known absolutely, the comparison point allows a check on self-consistency. When the spectral shape has been obtained from deuteron photodisintegration, secondary standards can be used if the detector efficiency is known. Alternatively the efficiency function can be checked by comparing several different nuclei. The method is applicable to photoneutron time-of-flight measurements. (auth)

30880 THE DEFORMED SPIN-ORBIT POTENTIAL IN NILSSON-MODEL CALCULATIONS. Van Rij, W. I.; Hess, C. T. (Florida State Univ., Tallahassee). Contract AT(40-1)-2434. Nucl. Phys.; A142: 72-80(1970).

A deformed spin-orbit potential of the Thomas form has been investigated in Nilsson-model calculations. Compared to the single-particle energy-level spacing, the level shifts due to deformation of the spin-orbit potential were found to be negligible for nuclei lighter than the rare earths. For the latter, however, the single-particle energies are shifted by up to 100 keV and reordering of some levels occurs. Single-particle energies in regions near the magic numbers 126 and 152 are shifted by up to 400 keV, showing that the spin-orbit deformation may be important in the prediction of stable super-heavy nuclei. The effect of the spin-orbit deformation on the single-particle wave function was found to be appreciable for all mass regions, the decoupling parameter, for example, changing by as much as 50%. Magnetic moments calculated for rare-earth nuclei change by up to 20%. (auth)

30881 DIFFERENTIAL EXCITATION CURVES FROM THICK TARGET NEUTRON SPECTRA. Wylie, W. R.; Bahnsen, R. M.; Lefevre, H. W. (Univ. of Oregon, Eugene). Nucl. Instrum. Methods; 79: 245-50(1970).

Use of the relationship between the continuous neutron spectrum which is produced when a charged particle beam reacts in a thick target, and the differential cross section of the reaction is discussed and is illustrated with experimental results. (auth)

30882 EXCITATION ENERGY OF A FREE FERMI GAS IN THE (n,2n) CHANNEL. Chatterjee, Swapna (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys.; A143: 277-88(1970).

Fast neutron induced (n, 2n) cross sections are estimated in

the framework of the free gas model. Since the observed excitation energy is measured from the effective Fermi surface of a real nucleus, a distinction is made between the model excitation energy and the experimentally observed excitation energy of a system. By removing the interactions in an actual nucleus, one can go over to the hypothetical free gas reference system. The interaction energies of a real system will then contribute to the total excitation energy of the free gas system. When nuclei with the same experimentally observed excitation energy are compared, the model excitation energies are altered depending on the nuclear interactions. These interaction energies change the observed excitation to the model excitation energy and convert a real system into a free gas system at matched excitation energies. The viewpoint is used here to obtain quantitative estimates of the fast (n, 2n) cross sections at 6 MeV residual excitation. The calculations agree fairly well with the experimental results. The limitations of the present viewpoint are discussed. (auth)

30883 INADEQUACY OF SIMPLE FINAL STATE INTERACTION THEOREM FOR A PAIR OF THREE IDENTICAL, OUTGOING PARTICLES. Ebenhoeh, W.; Rinat, A. S. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A143: 351-64 (1970).

An analysis is made of the cross section for breaking up a bound system composed of two particles by a third equivalent particle. Assuming separable pair interactions which allow for a bound state or resonance, the shape of the high-energy peak is investigated in its dependence on various parameters amongst which are low-energy scattering data for the participating pairs. This peak is usually explained in terms of the Migdal–Watson final-state interaction theorem applied to the pair of unobserved particles. It is shown that thus derived scattering parameters will usually deviate from the input parameters. The failure of this simple theorem may well account for the variation in measured neutron–neutron scattering lengths. (auth)

30884 FLUCTUATIONS AND SCATTERING OF SLOW PIONS IN NUCLEAR MATTER. Akhiezer, I. A.; Barts, B. I. (Kharkov State Univ.). Yadern. Fiz.; 11: 168-77(1970). (In Russian).

Fluctuations of nuclear matter (NM) are investigated in the Fermi-liquid model with account of both the nuclear and the electromagnetic interactions among the nucleons. It is shown that the electric forces modify essentially the characteristics of long-wave fluctuations of the NM density and of the charge density. In particular, sharp maxima arise in the expressions for correlators of the fluctuations, that are due to the possible propagation in NM of coupled oscillations of the density and the charge densities. Influence of the electric forces on the scattering of slow pions by nuclei is considered. The electric interactions of the incident pions with the nuclear protons as well as the interactions among the nucleons in NM are taken into account. It is shown that the account of the electric forces is necessary if the momentum transfer is no more that 30 MeV/c. (auth)

30885 BREMSSTRAHLUNG SPECTRUM IN DIRECT NUCLEAR REACTIONS. Kondratyuk, L. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 151-67 (1970). (In Russian).

The problem is studied of the possible use of the Bremsstrahlung spectrum in direct nuclear reaction for identification of the reaction mechanism. Amplitudes of the radiative decays for particles with arbitrary spins in the nonrelativistic case are calculated in the soft quanta approach with account of the charge radiation of the particles and of the contact radiation from the vertices. The γ-quanta bremsstrahlung spectrum is calculated for the pole and for the triangle graphs. It is shown that the spectra in both the cases have marked qualitative distinctions. A criterion of applicability of the method is given. (auth)

30886 DIFFRACTION SCATTERING OF CHARGED PARTICLES AND FRESNEL DIFFRACTION. Inopin, E. V.; Shebeko, A. V. (Physical-Technical Inst., Kharkov). Yadern. Fiz.; 11: 140-50(1970). (In Russian).

Analytical expressions for heavy particle elastic diffraction scattering cross sections are obtained. It is shown that the Frahn formula which describes the Fresnel-type diffraction is to be essentially improved. The improvement leads to reasonable agreement of the theory with the experiment. (auth)

30887 STATISTICAL ANALYSIS OF SPIN DEPENDENCE OF NEUTRON STRENGTH FUNCTIONS FOR NUCLEI. Maletski, Kh.; Pikel'ner, L. B.; Salamatin, I. M.; Sharapov, E. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 111-21(1970). (In Russian).

A simple analytical expression is obtained for distribution of neutron strength functions of nuclei. With this expression as basis, distribution of differences of the strength functions for two spin states is obtained. A statistical analysis performed for 28 nuclei shows that the experimentally observed differences of the strength functions for various spin systems are determined mainly by the statistical fluctuations of the neutron widths. (auth)

30888 METHOD OF SHELL CORRECTION. Tyapin, A. S. Yadern. Fiz.; 11: 98-104(1970). (In Russian).

The problem of the basis for the method of shell correction is discussed. It is shown that the shell correction is determined by the structure of one-particle states near the Fermi energy, that the method of shell correction is consistent in the first approximation, and that the method by Strutinsky is approximately valid. (auth)

30889 GENERALIZED CANONICAL TRANSFORMATIONS AND SYMMETRY PROPERTIES OF THE PAIR S = 0, T = 1 HAMILTONIAN. Afanas'ev, G. N. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz.; 11: 86-97(1970). (In Russian).

Transformation properties of the S = 0, T = 1 part of the Hamiltonian describing the np pair interaction with respect to the quasispin subgroups and to the symmetry group of the nonperturbed Hamiltonian are investigated. Behavior of levels with introduction of the np interaction is analyzed qualitatively. Conditions for the linear canonical transformation to exist are found. Physical classification of states of the charge symmetric Hamiltonian is given. (auth)

30890 PROPERTIES OF LOW-LYING 2^+ LEVELS. Malov, V. V.; Troitskii, M. A. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 11: 76-85(1970). (In Russian).

The variation of properties of low-lying 2^+ levels in nuclei with the variation of the number of particles in the region of nuclei which are magic in one type of particles is considered. The relation is given between the quadrupole moment of the 2^+ level and the quadrupole moments of neighboring nuclei in the ground state and the energy shift of the 2^+ level which appears in adding some particles to the nucleus. The strong decrease of the 2^+ level when adding a pair of particles to the closed shell is explained. The expression is obtained which makes it possible to calculate the variation of static moments of the 2^+ levels with the variation of the number of particles in the nucleus. (auth)

30891 POTENTIAL ENERGY SPLITTING ON THE SUPERMULTIPLET QUANTUM NUMBERS, SU(3) INVARIANT INTERACTIONS, AND THE TOTAL ORBITAL MOMENTUM OF THE NUCLEUS. Vanagas, V. V.; Kalinauskas, R. K. (Inst. of Physics and Mathematics, Vilnyus, USSR). Yadern. Fiz.; 11: 63-75(1970). (In Russian).

Using the supermultiplet model, an approximate dependence of the potential energy of the nucleus on the total spin S, isospin T, and orbital momentum L is obtained. General properties of the SU(3)-invariant energy with excharges, calculated in the unitary symmetry approximation in case of ground and oscillatory excited states of p and sd nuclei, are discussed. Some examples of p nuclei are presented to show the dependence of the position of anomalous parity energy levels on the quantum numbers of the unitary scheme model. Characteristic examples of the experimentally observed splitting on the orbital quantum number L for normal and anomalous parity levels of p and sd nuclei are presented. A possible theoretical interpretation of this splitting is discussed. (auth)

30892 CONTRIBUTION TO THE THEORY OF PERTURBED ANGULAR $\gamma\gamma$ CORRELATIONS FOR ORIENTED NUCLEI. Khaimovich, F. P. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 11: 59-62(1970). (In Russian).

The theory of perturbed angular $\gamma\gamma$ correlations for oriented nuclei is considered. A possibility of determining the sign of the quadrupole moment of excited nuclei is indicated. (auth)

30893 MULTIPLE SCATTERING CORRECTION FOR INELASTIC SCATTERING FROM CYLINDRICAL TARGETS. Engelbrecht, C. A. (Atomic Energy Board, Pelindaba, South Africa). Nucl. Instrum. Methods; 80: 187-91(1970).

Simple expressions are developed for the corrections for flux attenuation and multiple scattering of neutrons from cylindrical targets. (auth)

30894 ADIABATIC MODEL OF ASYMMETRIC FISSION. Dickmann, F. (Kernforschungszentrum, Karlsruhe, Ger.); Dietrich, K. pp 25-32 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

It is assumed that, in the process of fission, a potential barrier develops at a position $Z = Z_0$ (the symmetry axis of the nucleus is

chosen as Z-axis). Consequently, a neck is formed in the nuclear shape which leads to the final separation of the fragments. The barrier is represented by a repulsive δ-function which is added to the single-particle potential. The position z_0 of the neck is determined by requiring that the energy E(Z) needed to insert the barrier should have its smallest value. This picture presupposes an adiabatic fission process at the time of neck formation. Preliminary calculations were performed for the nuclei ^{246}Cf, ^{236}U, and ^{226}Ra using a cylindrical box as a highly simplified single-particle potential. For ^{246}Cf and ^{236}U the absolute minima of E(Z) were located at asymmetric positions z corresponding to the mass ratios 1.33 and 1.43, respectively. For ^{226}Ra, the absolute minimum of E(Z) was obtained for symmetric fission. However, a secondary minimum, only slightly larger in energy, was observed for the mass ratio 1.55. The ratio of the diameter to the length of the cylindrical box was 0.35 for the case of the above-mentioned results. (auth)

30895 INFLUENCE OF SHELL ENERGY ON THE DYNAMIC MODEL OF ASYMMETRIC FISSION. Hasse, R. W. (Univ., Wuerzburg, Ger.). pp 33-40 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The recently investigated dynamic model with a shell correction added to the liquid-drop potential allows the low-energy fission process of heavy nuclei to be described. The shell-correction term was taken to be the sum of the Myers and Swiatecki shell energies of two clusters in the compound nucleus undergoing fission, multiplied by an arbitrary attenuation factor which is equal to unity at the scission point and vanishes approximately at the saddle point. In this paper, the influence of the shell-energy correction term is studied, with special reference to the effect of its attenuation factor on results such as the mass distribution. For a vanishing shell correction the mass distribution is symmetric, whereas a full shell correction (attenuation factor equal to unity everywhere) yields the most asymmetric mass distribution. (auth)

30896 MASS AND CHARGE DISTRIBUTIONS IN FISSION. Ramamurthy, V. S.; Ramanna, R. (Bhabha Atomic Research Centre, Trombay, India). pp 41-50 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

During the last stages of the fission process, the fissioning nucleus can be very well approximated by two nuclei in close proximity, and the Hamiltonian of the system at this stage can be written as the sum of the Hamiltonians of two independent nuclei and a time-dependent interaction term. The wave function of the fissioning nucleus at any instant can be expanded in terms of base states, each representing a given mass configuration of the nascent fragments. The non-diagonal elements of the energy matrix in this representation give the probability that the fissioning nucleus goes from one base state to another. When the nascent fragments are sufficiently apart as to give a vanishingly small interaction term, changes in the mass configuration are not possible. This quantum-mechanical description of the division process is analogous to a classical stochastic process where the state space corresponding to the transition probabilities is given in terms of the non-diagonal elements of the energy matrix and the statistical weights associated with the transitions. In the present model, the description was simplified by replacing the time dependence with an average time-independent transition probability matrix. The final distribution of mass and charge is evaluated as the steady-state solution of the above stochastic process. The probability of transition from one configuration to an adjacent configuration was calculated from the transmission probability of the last nucleon through the potential barrier separating the nascent fragments. The deformation of the nascent fragments for a given mass configuration was determined by the condition of potential energy minimization. The excitation energy of the nascent fragments is small and, on the average, assumed to be equally divided between all the nucleons. It is shown that the asymmetric mass distribution in the low-energy fission of various heavy nuclei and the distribution of nuclear charge for fragments of given mass are well reproduced by using two adjustable parameters. The physical implications of these parameters are discussed. (auth)

30897 THEORY OF MASS YIELDS, KINETIC ENERGIES, AND FRAGMENT EXCITATION ENERGIES AS FUNCTIONS OF THE COMPOUND EXCITATION ENERGY. Noerenberg, W. (Univ., Heidelberg). pp 51-65 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

A first step towards a unified theory of fission is proposed in a simple model which allows the mass yield, the kinetic energies, and the fragment excitation energies to be described as functions of the compound excitation energy. The main assumptions of this model are: (1) a full statistical equilibrium of all degrees of freedom at the saddle point, and (2) strong coupling between collective degrees of freedom and weak coupling to non-collective degrees of freedom on the way from saddle to scission. The dependence of the various features of fission on the compound excitation energy comes in through the number of quasi-particle (qp) excitations at the saddle point and the collective temperature which characterizes the assumed statistical equilibrium of the collective degrees of freedom at the scission point. In particular the so-called molecular model of fission is used. In this model the compound nucleus is described by two interacting fragments. The centre-to-centre distance of the fragments is assumed to be large enough to treat the compound nucleus as a "molecule" bound by the outer nucleons. From the above assumptions for the motion from the saddle to the scission point the eigenenergies of the mass-asymmetr motion are a linear function of the number of (qp)-excitations at the saddle point. From a simple Boltzmann distribution one obtains the energy dependence of the ratio of symmetric-to-asymmetric mass yield. This ratio increases with increasing compound excitation energy. The mean kinetic energies of the fragments are determined by the Coulomb energy at the scissio point. The scission-point distance depends on the deformability of the fragments which, in turn, is a function of the number of quasi-particle excitations. The difference of the mean kinetic energy at two different compound excitation energies turns out to be approximately zero for symmetric fission and linear in the difference of the number of (qp)-excitations for asymmetric fission. For increasing compound excitation energies the mean kinetic energies of the fragments in asymmetric fission decreases. The loss in kinetic energy mainly appears as excitation energy of the heavier fragment which is nearly magic. The dependence of the mean number of (qp)-excitations on the compound excitation is explicitly given in a simple statistical model of level densities. Some experimental data are analyzed according to the theory and found to be in rather good agreement with the theory. (auth)

30898 A MODEL FOR FRAGMENT MASS-VERSUS-ENERGY CORRELATIONS IN FISSION. Schmitt, H. W. (Oak Ridge National Lab., Tenn.). pp 67-80 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

A detailed investigation of the two-spheroid model of the scission configuration in fission, including the study of both the classical and quantum mechanical properties of the system, is given. The most probable total fragment kinetic energy as a function of mass division is calculated from minimization of the total potential energy of the system. The root mean square width of the kinetic energy distribution is calculated from the quantum mechanical properties of the system. The local effective stiffness τ as a function of fragment mass m required for these calculations was obtained solely from correlated fragment kinetic energy measurements for thermal-neutron fission of ^{239}Pu, ^{241}Pu, and ^{235}U, together with the minimum potential energy hypothesis. Strong shell effects in the function $\tau(m)$ were found to occur in the region of $m \cong 132$, where $Z \cong 50$, $N \cong 82$; however, no shell effects seem to occur in the region of $m \cong 83$, where $N \cong 50$. We may interpret this result to indicate that for $N = 50$ proton-deficient nuclei, the ground-state well in the nuclear potential is relatively shallow, so that when these nuclei occur in fission they occur with distorted shapes outside the ground-state well, where the effective stiffness is reduced. Effective stiffnesses obtained for fragments of mass $82 \leq m \lesssim 112$ are within ~20% of the liquid-drop-model value. The stiffness parameters $\tau(m)$ are used together with minimization of the potential energy to calculate $\bar{E}_k(m)$, the average total fragment kinetic energy as a function of mass. In all cases examined to date, the calculated and experimental energies agree to within about 3%. The root-mean-square width $\sigma_{EK}(m)$ of the total kinetic energy distribution as a function of fragment mass is determined from quantum-mechanical properties of the system. Normal modes of the system are derived, and a harmonic approximation to the potential is used. Calculated and measured widths agree within about 20% for a wide range of fissioning nuclei. Discussions of the sensitivity of these results to the stiffness parameters, to the nuclear vibrational mass parameter, and to nuclear temperature are included. (auth)

30899 TERNARY FISSION. Feather, N. (Univ. of Edinburgh). pp 83-106 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Experimental results in the field of light-particle-accompanied fission (including fission accompanied by "scission neutrons")—

and in relation to fission into three fragments of comparable mass—are reviewed over the last four years. These results are set against the background of previously ascertained fact, and certain empirical regularities are noted. (auth)

30900 STATISTICAL THEORY OF NUCLEAR FISSION: α-PARTICLE EMISSION. Fong, P. (Emory Univ., Atlanta). pp 133-41 of Physics and Chemistry of Fission, Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Experimental information on angular correlation of the long-range α-particle emitted in ternary fission with the main fission fragments has recently become available. The results may be compared with theoretical predictions and, as it turned out, provide a very sensitive test of the theory of the fission mechanism. The moving apart of the two fragments and the α-particle under the action of the Coulomb forces between them is a classical three-body problem; it can be solved numerically by a high-speed computer if the initial conditions, i.e., the initial positions and velocities of the three particles at the scission point, are given. The initial conditions are so numerous and the dependence of the angular correlation on these conditions is so sensitive that it is impossible to reconstruct the initial conditions from the final experimental results. The statistical theory of nuclear fission dealing with the mechanism of fission leads to a complete specification of the initial conditions of the present problem and the computer calculation of the angular correlation based on them may be compared with the experimental results in a critical test of the theory. The calculated results are in good agreement with the experiments. In asymmetric fission in which the heavy fragment involves the 82-neutron shell, the α-particle is emitted veering towards the light fragment as expected from shell-effect considerations of nuclear deformability. On the other hand, in far asymmetric fission in which the light fragment involves the 50-neutron shell, the simple shell-effect argument predicts the α-particle veering towards the heavy fragment initially, but detailed dynamical calculation shows that this initial movement leads the α-particle into a region of retarding field and the α-particle is eventually pushed back and emitted veering towards the light fragment as experimentally observed. This reversal occurs only when the initial kinetic energy of the α-particle takes a value as small as that predicted by statistical theory (about 0.5 MeV). All dynamical theories are likely to lead to a higher value of this energy and it is, therefore, more difficult to account for the angular correlation. (auth)

30901 TRAJECTORY CALCULATIONS IN LIGHT-PARTICLE FISSION. Nardi, E. (Soreq Research Center, Rehovoth, Israel. Weizmann Inst. of Science, Rehovoth, Israel); Boneh, Y.; Fraenkel, Z. pp 143-52 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

Trajectory calculations based on a three-point-charge model were carried out for fission accompanied by ^{1}H, ^{2}H, ^{3}H, ^{4}He, ^{6}He, ^{8}He emission. The calculations were carried out with the intent of obtaining for each of these modes of fission the initial conditions which best fit the experimental results. The results indicate that both the initial distances between the fission fragments at scission and the initial kinetic energies of the particles tend to decrease as the mass of the light particle increases. In addition it was found that the experimental results could be better fitted by assuming that the particles are emitted off the axis connecting both fission fragments rather than on this axis. (auth)

30902 SHELL-STRUCTURE EFFECTS IN THE FISSIONING NUCLEUS. Strutinsky, V. M.; Pauli, H. C. (Univ. of Copenhagen). pp 155-81 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

A survey of the present state of fission theory is presented, with special emphasis on developments in the past few years. An attempt is made to bring out the more important problems to be settled by future experiments and theory. (auth)

30903 SINGLE-PARTICLE CALCULATIONS FOR DEFORMED POTENTIALS APPROPRIATE TO FISSION. Bolsterli, M.; Fiset, E. O.; Nix, J. R. (Los Alamos Scientific Lab., N. Mex.). pp 183-96 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The calculation of single-particle energies and wave functions in potentials whose shapes are appropriate to nuclear fission is considered. Each potential contains three terms: (1) a spin-independent axially symmetric part V_1, obtained by folding a Yukawa interaction with a uniform sharp-surface distribution that simulates the nuclear density distribution, (2) a Coulomb potential determined in an analogous way by integrating the Coulomb interaction over the corresponding sharp-surface distribution, and (3) an invariant spin-orbit term $\vec{\sigma} \cdot \vec{\nabla} V_1 \times \vec{p}$. For a spherical nucleus, V_1 is similar to a Woods-Saxon potential. As the nucleus deforms, V_1 deforms in a corresponding way, with a surface thickness that remains approximately constant for small deformations. At larger dumbbell-like deformations, the potential is somewhat deeper in the ends of the dumbbell, which is surrounded on all sides by nucleons, than in the neck region. Apart from its geometrical shape, the potential for neutrons contains four parameters: a depth, a radius, an analog of the surface thickness, and the spin-orbit interaction strength. These are determined by fitting the neutron single-particle and single-hole levels in ^{208}Pb. The sharp-surface nuclear shape is considered to be axially symmetric and is specified in terms of smoothly joined portions of three quadratic surfaces of revolution (e.g., two spheroids connected by a hyperboloidal neck). The two-dimensional coupled Schroedinger equations are solved by a finite-difference method that is an improved version of the procedure described by Dickmann. Preliminary results are presented for the neutron levels near the Fermi surface in ^{234}U for shapes ranging from a sphere to an elongated symmetric dumbbell beyond the saddle point. The calculated levels at the saddle point are compared with the transition states deduced from ^{235}U fission cross-sections and fission-fragment angular distributions. The preliminary comparison indicates approximate agreement between the calculated and experimental transition states, but there are calculated states of high angular momentum near the Fermi surface that are not excited in the low-energy neutron-induced fission of this nucleus. (auth)

30904 FISSION BARRIERS AND SADDLE-POINT SHAPES. Krappe, H. J.; Wille, U. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). pp 197-211 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The energy of rare-earth and heavy fissile nuclei is calculated as a function of quadrupole, octupole, and hexadecapole deformations. The liquid-drop model is used with shell corrections according to a method proposed by Strutinsky. The liquid-drop part of the deformation energy is treated exactly by numerical integration. In the shell-model part potentials of the Saxon–Woods type as well as harmonic oscillator potentials are used. Though the latter can more easily be treated numerically, certain ambiguities arise from the various parameters entering in their definition. These are investigated by comparison with the results obtained with use of the Saxon–Woods potential. The symmetry energy and charge radius parameters in the liquid-drop part of the binding energy were taken from Seeger's work. The geometrical parameters defining the single-particle potential and the spin-orbit coupling strength were fitted to the energy-level sequence near the Fermi surface or to nucleon scattering data analyzed within the optical model. The pairing strength is chosen to reproduce the region of deformed nuclei correctly and to give the over-all trend of odd-even mass differences. The ground-state deformation, fission-barrier heights and locations, and the excitation energy of shape isomers are calculated for various nuclei of the rare-earth and actinide region. (auth)

30905 MASS AND INERTIA PARAMETERS FOR NUCLEAR FISSION. Damgaard, J.; Pauli, H. C.; Strutinsky, V. M.; Wong, C. Y.; Brack, M.; Stenholm-Jensen, A. (Univ. of Copenhagen). pp 213-27 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The effective mass parameter and the moments of inertia for a deformed nucleus are evaluated using the cranking-model formalism. Special attention is paid to the dependence of these quantities on the intrinsic structure, which may arise due to shells in deformed nuclei. It is found that these inertial parameters are very much influenced by the shells present. The effective-mass parameter, which appears in an important way in the theory of spontaneous fission, fluctuates in the same manner as the shell-energy corrections. Its values at the fission barrier are up to two or three times larger than those at the equilibrium minima. This correlation comes about because for the effective mass the change in the local density of single-particle states is very important, much more so than the change in the pairing correlation. The moments of inertia which enter in the theory of angular anisotropy of fission fragments, also fluctuate as a function of the deformation. At low temperatures, the fluctuation is large and shows a distinct but more complicated correlation with the

shells. At high temperatures, the moments of inertia fluctuate with a smaller amplitude about the rigid-body value in correlation with the energy-shell corrections. For the first and second barriers, the rigid-body values are essentially reached at a nuclear temperature of 0.8 to 1.0 MeV. (auth)

30906 ENERGY LEVELS IN A DEFORMED POTENTIAL WELL WITH STEEP EDGES. Gaudin, M.; Sajot, A. M. (CEN, Saclay, France). pp 229-45 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969). (In French).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

An exact numerical determination is attempted for the energy levels of a particle in a potential well with steep edges by the determinantal method, which was already described by Hill and Wheeler in 1953. This method is applied to a very schematic nuclear model in which the mean potential is local, independent of spin and charge, and constant or infinitely deep inside a surface limiting a fixed volume. In practice one is limited to axial and reflection symmetry and a two-parameter surface family (α_2,α_4) although it is very well possible to introduce an asymmetry (α_3). The preliminary results enable one, as far as the infinite well is concerned, to: (a) obtain the position of the first levels up to four exact digits in the region $0 < \alpha_2 < 0.40$, $0 < \alpha_4 < 0.15$; (b) determine the total energy of a system of independent nucleons in its ground state, by the direct method of "summation over the levels"; to compare this energy with the expression given by the classical asymptotic formula for a fermion gas (Hill and Wheeler) and to obtain—as difference—a "shell correction" (Strutinsky) referring to this schematic model; (c) calculate the relative proportion of the occupied even and odd levels (reflection parity) as a function of the deformation (in connection with the ideas of Kelson and Griffin on the asymmetric fission). As to the finite potential well, the results enable one to: (d) obtain, with lower accuracy (of the order of 1%), the variation of the ensemble of levels with a deformation parameter α_2 in the region $0 < \alpha_2 < 0.45$. (auth)

30907 STRUCTURE PHENOMENA IN NEAR-BARRIER FISSION REACTIONS. Lynn, J. E. (Atomic Energy Research Establishment, Harwell, Eng.). pp 249-81 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The double-humped Strutinsky potential governing the behavior of actinide nuclei in quadrupole deformation is now known to explain a wealth of data in low-energy fission. The results of various particle-induced reactions leading to fission in the near-barrier energy range are reviewed and interpreted. First, a general formal theory which allows for the discussion of structure effects within the framework of the channel theory of fission is summarized. This is applied to the treatment of the case when the second minimum in the potential energy curve is shallow, and structure in the fission yield as a function of energy can be ascribed to an undamped vibrational level in this shallow well. The neutron-induced fission cross section of ^{230}Th seems to provide a clear example of this phenomenon. The opposite case is that in which the second minimum is quite deep and the highest vibrational states in this well are rather strongly damped into much more complicated states (class-II states) of a compound nucleus type. The class-II states are coupled to the denser fine structure resonances (class-I states) and the coupling strength relative to the fine structure spacing and class-II fission width governs a number of different phenomena. The most obvious case, when the coupling is very weak and the class-II state is narrow, gives cross sections that can be treated consistently by simple perturbation theory. The narrow intermediate structure in the slow neutron-induced fission cross sections of ^{240}Pu, ^{242}Pu, and ^{237}Np almost certainly provide good examples of this. When the class-I–class-II coupling is large compared with the fine structure spacing the intermediate structure has basically a Lorentzian dependence. On the other hand, if the class-II fission width is large quasi-Lorentzian groups appear; these are virtually indistinguishable (in the cross section) from the former case. Examples of the two cases are provided by the slow neutron cross-section of ^{234}U and ^{241}Am. Intermediate cases are also discussed. Weak and moderate damping of the vibrational states of the second minimum into the class-II compound states is also a possibility that can occur. Examples of this seem to be illustrated by the ^{241}Am(n,f) and ^{239}Pu(d,pf) reactions. Finally all the data are surveyed in terms of the information they give us concerning the double-humped fission barrier. There seems to be a clear trend from a shallow second minimum in the region of ^{231}Th to maximum development around ^{241}Pu. (auth)

30908 DOUBLE-HUMPED BARRIER IN THE QUASI-CLASSICAL APPROXIMATION. Gai, E. V.; Ignatyuk, A. V.; Rabotnov, N. S.; Smirenkii, G. N. (Inst. of Physics and Power Engineering, Obninsk, USSR). pp 337-47 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969). (In Russian).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The energy dependence of the penetrability of a double-humped potential barrier with a valley between the peaks is determined in the penetrability of a double-humped potential barrier with a valley between the peaks is determined in the quasi-classical approximation. It is shown that the penetrability of the barrier fluctuates sharply, reaching maximum values at energies coinciding with the positions of the quasi-stationary levels in the valley. The results are used in analyzing experimental data on neutron fission. (auth)

30909 EMISSION OF DELAYED NEUTRONS: CALCULATION OF THE ENERGY SPECTRA AND EMISSION PROBABILITIES OF THE PRECURSORS. Gauvin, H.; de Tourreil, R. (Institut de Physique Nucleaire, Orsay, France). pp 621-36 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969). (In French).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

The calculations given are intended to explain the delayed neutron emission (energy spectra and emission probabilities P_n) which follows the β^- disintegration of the precursors produced by fission. The probability of β^- transition, the level density $\omega(E,J)$ of the emitter and the competition (β^-,γ) and (β^-,n) de-energizations are analyzed for each precursor studied. All the possible channels open to the process of neutron emission on grounds of energy considerations (Q_{β^-},B_n) are taken into account through the introduction of the spin and parity selection rules at each stage of the sequence; precursor, emitter, final nucleus. The results of the calculations are compared with the known experimental measurements of the neutron energy spectra and probabilities P_n. The precursors ^{87}Br, ^{88}Br, ^{137}I, and $^{93-97}$Rb were selected for this examination. This comparison shows in particular that the structure of experimental energy spectra can be well reproduced by the calculations given. Moreover, it emerges that the spectra calculated are very sensitive to the choice of the spins of the precursor and the final nucleus. (auth)

30910 THE EFFECTS OF NUCLEAR EXCITATION OF PROMPT FRAGMENTS ON THE INDEPENDENT YIELDS AND NEUTRON YIELDS IN FISSION. Thind, K. S.; Tracy, B. L.; Thode, H. G.; Tomlinson, R. H. (McMaster Univ., Hamilton, Ont.). pp 845-60 of Physics and Chemistry of Fission. Vienna; International Atomic Energy Agency (1969).

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria. See STI/PUB-234; CONF-690708.

It has been found possible to account for the fine structure in the neutron yield versus mass distribution. The prediction is based on the assumption of a prompt independent curve obtained from the equal-charge-displacement (ECD) postulate and a linear dependence of fission-fragment excitation energy with mass. The method adopted for calculating neutron yields was used to investigate the effect of neutron emission on independent yields. Independent yields after neutron emission were calculated using ECD and a "transition-state" method to describe the prompt charge distribution. The calculated independent yields were compared with some recent data. (auth)

30911 GENERAL EXPRESSIONS OF WIGNER–MAJORANA ENERGY AND SOME RELATIONS FOR THE MATRIX ELEMENTS OF THE SU_3-INVARIANT INTERACTIONS FOR THE ARBITRARY GROUND CONFIGURATIONS OF NUCLEI. Kalinauskas, R.; Vanagas, V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos; 9: 655-64(1969). (In Russian).

The probabilities Q of forming a pair of nucleons characterized by definite orbital quantum numbers of the relative movements in the unitary symmetry scheme model approximation is discussed. The explicit expressions of those probabilities in terms of the fractional parentage coefficients are given. Three linear relations between Q in terms of the eigenvalues of the invariant operators in case of any ground SU_3-configuration of the nuclei are presented. (auth)

30912 GENERAL FEATURES OF THE BILINEAR FORM CONSTRUCTED FROM THE INFINITESIMAL OPERATORS OF THE $U_{3(n-1)}$-GROUP. Kalinauskas, R.; Vanagas, V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos; 9: 665-73 (1969). (In Russian).

The bilinear form, serving for the approximation of the central internuclear interaction, constructed by help of the infinitesimal operators of the $U_{3(n-1)}$-group, is discussed. The transformation of this form from one-particle to Jacobi coordinates is performed. The transformational properties of this bilinear form with respect to the unitary symmetry scheme groups are investigated. All $U_{3(n-1)}$-irreducible terms, invariant to the symmetrical and three-dimensional rotational groups are enumerated. (auth)

30913 THE IRREDUCIBLE STRUCTURE OF THE BILINEAR FORMS CONSTRUCTED FROM THE INFINITESIMAL OPERATORS OF THE $U_{3(n-1)}$-GROUP. Kalinauskas, R.; Vanagas, V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos; 9: 675-83(1969). (In Russian).

The relations between special bilinear forms constructed from the infinitesimal operators of the $U_{3(n-1)}$-group, and internuclear interactions, expressed in terms of the oscillatory energy operator quadrate, as well as the orbital momentum of the two-nucleon relative movements are investigated. The expression of those bilinear forms in terms of $U_{3(n-1)}$-irreducible components are obtained and concrete formulas for calculating of components in the unitary symmetry scheme model are given. (auth)

30914 THOMAS–FERMI CALCULATIONS IN NUCLEI. Dahll, Gustav (NORDITA, Copenhagen); Warke, Chindu. Nucl. Phys.; A147: 94-106(1970).

The Thomas–Fermi theory was used to calculate the energy per particle, the density distribution, and the single-particle potential for neutrons and protons in finite nuclei. The calculation was performed for the nuclei ^{208}Pb, ^{140}Ce, ^{120}Sn, and ^{90}Zr. The binding energies per particle were 0.5 to 0.8 MeV too small, the rms radii of the density distributions were well reproduced, whereas the surface thickness was too small. (auth)

30915 ONE-PARTICLE TRANSFER REACTIONS TO HIGHLY EXCITED STATES IN DEFORMED NUCLEI. Andersen, B. L.; Back, B. B.; Bang, J. M. (Univ. of Copenhagen). Nucl. Phys.; A147: 33-44(1970).

A method for calculation of single-particle wave functions in a deformed Woods–Saxon potential is developed. The wave functions are used as form factors in stripping and pick-up calculations, and the resulting cross sections are compared to experimental data. (auth)

30916 ALPHA-PARTICLE TYPE FOUR-BODY CORRELATION IN ^{212}Po. Sasaki, Kiyoshi (Nihon Univ., Chiba, Japan); Suekane, Shota; Tonozuka, Isao. Nucl. Phys.; A147: 45-53 (1970).

It is shown that a configuration in which two protons are excited from the pure shell-model ground state configuration to the same orbit as the uppermost occupied neutron orbit contributes appreciably to the α-decay reduced width of ^{212}Po. This configuration has been neglected in most shell-model calculations. It is noted that the four-body correlation is enhanced by this new configuration if the effective interaction is attractive in the singlet-even state; this condition coincides with that on the effective interaction in order that an α-cluster be formed. If the conventional low-lying configurations are included, the α-decay reduced width of ^{212}Po becomes twice as large as that for the configuration mixing calculations by Harada. It is also suggested that there may be states with strong α-type correlation among excited states. (auth)

30917 DIFFRACTION MODEL AND NUCLEAR TRANSFER PROCESSES. Rihan, T. H. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; A147: 54-64(1970).

The amplitude for nuclear transfer processes is evaluated by means of a diffraction model formalism. The finite-range effects are taken into account adopting some reasonable approximations. The difference between the initial and final channel partial waves is also included. It is found that the latter effect leads to a modification of the normalization of the differential cross section by an order of magnitude besides improving the fitting to the data. The results obtained are illustrated by some examples. (auth)

30918 RADIATIVE CORRECTIONS OF ORDER $Z\alpha^2$ TO $0^+ - 0^+$ β-TRANSITIONS. Jaus, W.; Rasche, G. (Univ., Zurich). Nucl. Phys.; A143: 202-12(1970).

The radiative corrections of order $Z\alpha^2$ to pure Fermi decays are studied in detail. The result is applied to the experimentally accessible pure Fermi decays. These additional radiative corrections to the ft values range from +0.3% for ^{14}O to +1.6% for ^{54}Co. (auth)

30919 COLLECTIVE TREATMENT OF THE PAIRING HAMILTONIAN. I. FORMULATION OF THE MODEL. Bes, D. R. (Univ. of Minnesota, Minneapolis); Broglia, R. A.; Perazzo, R. P. J.; Kumar, K. Contract AT(11-1)-1764. Nucl. Phys.; A143: 1-33(1970).

A treatment of the pairing force problem in terms of two collective variables—the intrinsic deformation α and the gauge angle ϕ—is developed. The comparison between the results obtained solving the corresponding quantum mechanical Hamiltonian and those obtained by an exact diagonalization shows the adequacy of the present approach. (auth)

30920 TWO-BODY AND THREE-BODY CORRELATIONS IN NUCLEAR MATTER. Lawson, P. A. (Paisley Coll. of Tech., Scotland). Nucl. Phys.; A143: 65-77(1970).

The contribution to the binding energy of nuclear matter from two-body correlations, calculated for the two hard-core potentials of Hamada–Johnston and Reid, give an energy of 7–9 MeV. The single-particle potential for states above the Fermi sea is taken to be zero and a separate calculation of the three-body correlations is performed using a potential acting only in S-states. The momentum dependence of the three-body energy is explicitly taken into account, and the most accurate results provide at $k_F = 1.35$ fm^{-1} an extra 2.4 MeV binding from three-body correlations. The effect on the three-body energy of changing the form of the two-body defect wave functions is investigated in some detail. (auth)

30921 APPLICATIONS OF TIME-DEPENDENT PERTURBATION THEORY IN COMPUTATIONS OF THEORETICAL MOESSBAUER SPECTRA. Tumolillo, Thomas A. (Univ. of Illinois, Urbana). Nucl. Phys.; A143: 78-96(1970).

Theoretical formulas are derived which describe several types of Mössbauer experiments; they are a) the effect of a fluctuating hyperfine field on the time dependence of Mössbauer transmission, b) the calculation of Mössbauer transmission spectra for static hyperfine fields, and c) time reversal invariance tests in a Mössbauer scattering experiment. (auth)

30922 NONINVARIANCE GROUPS IN THE SECOND-QUANTIZATION PICTURE AND THEIR APPLICATIONS. Moshinsky, M.; Quesne, C. (Univ. of Mexico, Mexico City). J. Math. Phys. (N. Y.); 11: 1631-9(May 1970).

The existence of noninvariance groups in the second-quantization picture for fermions distributed in a finite number of states are investigated. The case of identical fermions in a single shell of angular momentum j is treated in detail. It is shown that the largest noninvariance group is a unitary group $U(2^{2j+1})$. The explicit form of its generators is given both in the m scheme and in the seniority–angular-momentum basis. The full set of 0-, 1-, 2-, ..., (2j + 1)-particle states in the j shell is shown to generate a basis for the single irreducible representation [1] of $U(2^{2j+1})$. The notion of complementary subgroups within a given irreducible representation of a larger group is defined, and the complementary groups of all the groups commonly used in classifying the states in the j shell are derived within the irreducible representation [1] of $U(2^{2j+1})$. These concepts are applied to the treatment of many-body forces, the state-labeling problem and the quasiparticle picture. Finally, the generalization to more complex configurations is briefly discussed. (auth)

30923 HARTREE–FOCK CALCULATIONS FOR LIGHT NUCLEI. Guiasu, I.; Iosifescu, M.; Scutaru, H.; Cristu, M. (Inst. for Atomic Physics, Bucharest). Lett. Nuovo Cim.; 3: 279-84(26 Feb 1970).

A preliminary investigation is made of the accuracy of the Hartree–Fock (HF) approximation for a calculation of binding energies that begins with the realistic potential extracted from the nucleon–nucleon elastic-scattering phase shifts. Axial symmetry, time reversal, and charge invariance of the HF single-particle Hamiltonian are assumed, and the calculations are restricted to nuclei with $\bar{N} = Z =$ even. The harmonic-oscillator shell-model basis without mixing parities or major shells is used. (L.W.A.)

30924 PERTURBATION TREATMENT OF THE CONFIGURATION MIXING IN S.C.S. NUCLEI. Nomura, M. (Tokyo Univ.). Lett. Nuovo Cim.; 3: 323-8(7 Mar 1970).

The perturbation treatment of the configuration mixing in the low-lying states of the single-closed shell nuclei, expressed in the zeroth-order approximation by the configuration j^N (j is spin) with seniority less than 3, is discussed. (L.W.A.)

30925 HOW TO CALCULATE THE NUCLEAR DEFORMATION-ENERGY SURFACE FROM A SINGLE PARTICLE POTENTIAL. Faessler, A.; Slavov, B. (Univ., Muenster, Ger.). Phys. Lett.; 31B: 350-2(16 Mar 1970).

A method is proposed for the calculation of the nuclear deformation energy surface from a single particle potential which is

correct in the light of the Hartree–Fock theory. The method is applied to ^{20}Ne and compared with the usual prescription. (auth)

30926 NON-STATISTICAL EFFECTS IN NEUTRON RESONANCE CAPTURE. Lane, A. M. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Phys. Lett.; 31B: 344-6 (16 Mar 1970).

A compact formalism is given for discussing resonance correlations with the "doorway" viewpoint of Chrien and Bartholomew. Doorway properties needed for correlations are pin-pointed. Calculations show such properties to be reasonable. This success suggests directions for further experiments. (auth)

30927 CONTINUUM CONTRIBUTION TO THE PARTICLE UNSTABLE STATES. Fodor, I. (Central Research Inst. for Physics, Budapest). Phys. Lett.; 31B: 336-8(16 Mar 1970).

An estimation for the value of the $\Gamma^{\dagger}/\Gamma_{tot}$ ratio in the case of a quasi-bound state embedded in the continuum is obtained on the basis of particle transfer reactions leading to analog and anti-analog states. (auth)

30928 APPLICATION OF THE K HARMONICS METHOD TO CALCULATIONS OF NUCLEAR PROPERTIES. GENERAL FORMULAS. Baz, A. I.; Zhukov, M. V. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 11: 779-89(Apr 1970). (In Russian).

A simple method for applications of techniques to calculate properties of low-lying levels of arbitrary nuclei is developed in the $K = K_{min}$ approximation of the K-harmonics method. The calculation scheme is formally like the shell model approach, though no self-consistent field is introduced and only basic physical assumptions contained in the K-harmonics method are used for the deduction. The techniques developed in view of the nuclear shell model may well be used when applying the new method of calculations. (auth)

30929 $\beta\gamma$ CORRELATIONS IN ONCE-FORBIDDEN β TRANSITIONS OF NUCLEI AT $72 \leq A \leq 86$. Batkin, I. S.; Kopytin, I. V. (Voronezh State Univ., USSR). Yadern. Fiz.; 11: 770-8(Apr 1970). (In Russian).

Based on the nuclear matrix elements obtained before, calculations are carried out of various $\beta\gamma$ correlation effects for nuclei from the interval $72 \leq A \leq 86$ (once-forbidden transitions of the type $J_i^- \xrightarrow{\beta} 2^+ \xrightarrow{\gamma} 0^+$ are considered only). The calculations of the correlation coefficients are performed with the exact formulas as well as in framework of the "modified" B_{ij} approach. Detailed comparison with the experiment is carried out for the isotopes ^{72}Ga, ^{76}As, ^{84}Rb, ^{86}Rb. It is shown that the model scheme for calculation of nuclear parameters presented previously allows one to describe properties of nuclei in the indicated region rather satisfactorily. (auth)

30930 NUCLEON INTERACTION AMPLITUDE IN INFINITE NUCLEAR MATTER. Sapershtein, E. E.; Khodel, V. A. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 11: 760-9(Apr 1970). (In Russian).

The properties of the nucleon scattering amplitude in infinite matter playing the role of universal interaction between quasiparticles in the nucleus are analyzed. It is shown that due to the absence of Galilean invariance, the number of independent invariant scattering amplitudes in the matter increases. The general expression for the quasiparticle scattering amplitude near the Fermi surface is derived, containing eight (instead of five in vacuum) invariant amplitudes which are analytical functions of kinematic invariants of the problem. The general form of the nucleon interaction amplitude in nuclear matter violating parity is obtained. Stability conditions of nuclear matter under long-range collective excitations and Cooper pairing are studied. (auth)

30931 ROTATION AS INTRINSIC NUCLEAR EXCITATION. Belyaev, S. T.; Zelevinskii, V. G. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz.; 11: 741-59(Apr 1970). (In Russian).

A microscopic theory of rotational excitations of atomic nuclei is constructed. The rotation is considered as an equal branch of the collective excitation spectrum without involving a concept of a forced rotation. The method is a subsequent solution of the operator equations of motion and enables one to find all matrix elements of the operators inside the rotation band and the momentum of inertia that coincides with the result of the cranking model in the adiabatic approximation. Conventional concepts of deformed self-consistent fields, the proper coordinate frame for the nucleus, etc., are not assumed a priori and arise as a result of the solution. The present method is compared with other approaches. (auth)

30932 NONLOCALITIES IN THE RESIDUAL INTERACTION FOR SHELL-MODEL CALCULATIONS OF ^{18}O AND ^{18}F. Stocker, W. (Univ., Munich). Lett. Nuovo Cim.; 1: 605-7(21 Apr 1969).

The use of unitary transformation of the two-body Hamiltonian — containing hard-core parts — to construct regular nonlocal equivalent potentials is presented. The nonlocalities in the residual interaction for shell-model calculations of ^{18}O and ^{18}F are discussed. (L.W.A.)

30933 HOLE AND NEGATIVE-PARITY STATES IN THE ASYMMETRIC-CORE COLLECTIVE MODEL FOR ODD-A NUCLEI IN THE 2s–1d SHELL. Dumazet, G.; Lambert, M.; Onimus, J. P. (Inst. of Nuclear Studies, Algiers). Lett. Nuovo Cim.; 1: 553-7(21 Apr 1969).

The difficulties encountered with the asymmetric-core collective model for odd-A nuclei in the 2s-1d shell, how they may be overcome, and the effect of inclusion of more complicated configurations like holes and negative-parity ones are discussed. (L.W.A.)

30934 NORMALIZATION PROBLEM ASSOCIATED WITH THE HOMOGENEOUS VERTEX PART EQUATION OF A MANY-FERMION SYSTEM. Nyberg, J. (Univ. of Oslo). Lett. Nuovo Cim.; 3: 335-8(14 Mar 1970).

An attempt is made to demonstrate a simple way of constructing the correctly normalized residue of the vertex part for an infinite many-fermion system, using the solutions of the homogeneous vertex part equation. The problem is connected with the problem of normalizing the particle-hole wave functions of the system. (L.W.A.)

30935 NUCLIDIC MASS MEASUREMENT BY ION CYCLOTRON RESONANCE. Fujiwara, Shizuo (Tokyo Univ.). Bull. Chem. Soc. Jap.; 43: 561-3(Feb 1970).

The use of ion cyclotron-resonance spectroscopy (ICRS) for the measurement of nuclidic masses is briefly discussed. The application of the double-resonance technique of magnetic resonance to ICRS, thus making it useful for the investigation of the kinetics of organic reactions, is mentioned. (L.W.A.)

30936 EQUIVALENCE AND THEORETICAL FOUNDATION OF RECENT PHENOMENOLOGICAL DESCRIPTIONS OF ROTATIONAL BANDS IN DEFORMED NUCLEI. Klein, A. (Princeton Univ., N. J.); Dreizler, R. M.; Das, T. K. Phys. Lett.; 31B: 333-5(16 Mar 1970).

Two recent successful phenomenological descriptions of ground state rotational bands in even nuclei are proven to be equivalent. A rigorous derivation of one of them (the Harris formula) is given and its significance discussed. (auth)

30937 PHENOMENOLOGICAL ANALYSIS OF ROTATIONAL BANDS OF DEFORMED EVEN–EVEN NUCLEI. Begzhanov, R. B.; Belen'kii, V. M. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 8, 17-20(1969). (In Russian).

Rotational bands of even-even nuclei were studied using various models. Excited state energies of the basic rotational band and the γ- and β-bands were calculated within the limits of non-adiabatic and rotational vibration theories. Experimental data were correlated to the spectra calculated accordingly for deformed nuclei with $150 < A < 180$ and $A > 220$. The results showed that in case of spherical nuclei both theories are in worse agreement than for deformed nuclei. However, the non-adiabatic theory is closer to the experimental data than the R-V theory. (R.V.J.)

30938 ISOBARIC ANALOGUE RESONANCES IN PROTON ELASTIC AND INELASTIC SCATTERING. Bund, G. W. (Instituto de Fisica Teorica, Sao Paulo, Brazil); Blair, J. S. Nucl. Phys.; A144: 384-406(1970).

A model for proton elastic and inelastic scattering at isobaric analog resonances in the one level approximation is presented. The basic assumptions made are that the coupling of the open channels to compound nuclear states with isobaric spin $T_<-\frac{1}{2}$ is simulated by a phenomenological complex potential acting in the entrance and exit channels and that internal mixing of the isobaric analogue state with complicated compound nuclear states is small. The fractional parentage expansions characteristic of (d,p) stripping reactions on the parent states are explicitly introduced. The elastic and inelastic partial widths and the total width for the analog of the ground state of ^{208}Pb are studied for different optical potentials and partial agreement with experiment is obtained. (auth)

30939 NUCLEAR HARTREE–FOCK CALCULATIONS WITH A SIMPLE REACTION MATRIX. Koehler, H. S. (Rice Univ., Houston, Tex.). Nucl. Phys.; A144: 407-16(1970).

Self-consistent field (Hartree–Fock) calculations on several finite nuclei are presented. A non-local (momentum dependent) interaction is used. This interaction has some of the important structure of a reaction-matrix derived from realistic nucleon forces. It is adjusted to reproduce mass-formula parameters of Myers and Swiatecki. Good agreement with experimental binding

energies and radii is obtained except for nuclei with $A \leqq 16$. Of considerable interest is the agreement with radii because the density of nuclear matter deduced by Myers and Swiatecki is 0.1365 fm^{-3} and this is considerably less than 0.17 or 0.19 fm^{-3} which have been the accepted values in most previous works. The binding energies of e.g., the Ca isotopes is considerably improved by adding a spin-orbit potential to the states of the least bound nucleons in the $j = l + 1/2$ shells. (auth)

30940 ANALYTIC CONTINUATION OF A LIPPMANN–SCHWINGER KERNEL. Heiss, W. D. (Univ., Heidelberg). Nucl. Phys.; A144: 417-28(1970).

For the two-particle case it is shown that under suitable conditions on the potential the Weinberg method works also in the lower k-plane, i.e., the series of separable kernels converges if the individual terms can be continued. The individual terms may have singularities which cancel in the series. Further singularities correspond to those of the continued Jost function. The square well is treated as an example and in this case the different eigenvalues of the Lippmann–Schwinger kernel are given by one analytic function evaluated on different sheets. (auth)

30941 PION ABSORPTION FOLLOWED BY TWO-NUCLEON EMISSION. Elsaesser, W.; Eisenberg, J. M. (Univ. of Virginia, Charlottesville). Nucl. Phys.; A144: 441-8(1970).

The process is considered in which a negative pion in a 2P atomic orbital is captured on a correlated pair of nucleons. Mutual final-state scattering of the emitted nucleons is taken into account. The absorption process is treated in perturbation theory using a nonrelativistic pion–nucleon interaction. Asymptotic radial wave functions of the emitted nucleon pair, used in earlier works, are replaced by radial wave functions in a realistic nucleon–nucleon potential. The results are significantly affected by this substitution. Numerical results, including angular and energy distributions and absorption rates, are presented for pair emission from the $1s_{1/2}$ and $1p_{1/2}$ subshells. (auth)

30942 HARTREE–FOCK–BOGOLYUBOV CALCULATIONS WITH A REALISTIC NUCLEON–NUCLEON INTERACTION. Khadkikar, S. B.; Gunye, M. R. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys.; A144: 289-304(1970).

The Hartree–Fock (HF) and Hartree–Fock–Bogolyubov (HFB) calculations for doubly even nuclei in p-, sd- and pf-shells are carried out in the model space of the first four major shells. The effective nucleon–nucleon (NN) interaction derived by Elliott et al. directly from the observed NN scattering phase-shifts is employed in the calculations. It is found that the nuclei in p-shell do not show pairing effects since the HF gap near the Fermi surface is quite large. However, at the end of p-shell, ^{14}C which is almost spherical and has a small HF gap for neutrons, shows large pairing effects. The pairing effects in sd-shell are clearly seen in the nuclei with either N = 12 or Z = 12 or both. The HF gaps in almost all pf-shell nuclei are quite small and consequently these nuclei exhibit large pairing effects. The computed binding energies and the inertial parameters ($\hbar^2/2I$) are considerably smaller than the corresponding experimental values. The computed rms radii are also somewhat smaller than the experimental values. A good agreement in the binding energies and rms radii can be obtained if the $^3S_1$ matrix elements of the employed NN interaction are reasonably modified. (auth)

30943 DETERMINATION OF THE $f_{7/2}$–$d_{5/2}$ EFFECTIVE INTERACTION USING MULTIPOLE SUM RULE METHODS. Moinester, M. A.; Alford, W. P. (Univ. of Rochester, N. Y.). Nucl. Phys.; A144: 305-20(1970).

Using the multipole sum rule technique of French and Bansal, data from a number of nuclei in the sd-shell were analyzed to estimate the matrix elements of the $f_{7/2}$–$d_{5/2}$ effective interaction. The matrix elements obtained in this way are compared with those from other analyses using the more standard procedure of fitting energy levels, and reasonable agreement is obtained. A comparison with the results of reaction matrix calculations employing realistic two-body interactions is also presented. (auth)

30944 MATRIX ELEMENTS OF THE RESIDUAL INTERACTION IN THE sd-SHELL. Abulaffio, Carla (Technion-Israel Inst. of Tech., Haifa). Nucl. Phys.; A144: 225-35(1970).

Two-body matrix elements of the residual interaction computed by different methods are compared. It is found that Kuo's matrix elements connect states of different spin and that both Kuo's and Elliott's matrix elements substantiate the evidence that the non-central character of the residual interaction cannot be overlooked. Elliott's results are compared with matrix elements derived from nuclear level data. The agreement is poor. A possible way to improve the agreement is outlined. (auth)

30945 AN APPROXIMATION TO OFF-DIAGONAL REACTION MATRIX ELEMENTS. Srivastava, M. K. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A144: 236-44(1970).

A method based on a local static approximation to the free reaction matrix is presented for the calculation of off-diagonal, also called half-off-energy-shell matrix elements directly from the scattering parameters. It is found to be reasonably accurate for partial waves with $l \geqq 2$. (auth)

30946 HIGHER PARTIAL WAVES CONTRIBUTION TO NUCLEAR MATTER BINDING ENERGY. Sprung, D. W. L.; Banerjee, P. K.; Jopko, A. M.; Srivastava, M. K. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A144: 245-53(1970).

The contribution of the states with $J \geqq 3$ to nuclear matter binding energy is estimated directly from the phase shifts to be $+0.7 \pm 0.2$ MeV per particle. (auth)

30947 COLLECTIVE COORDINATES FOR THE DESCRIPTION OF NUCLEAR ROTATIONS. Gupta, V.; Skinner, R. (Univ. of Saskatchewan, Saskatoon). Phys. Lett.; 31B: 256-8 (2 Mar 1970).

Collective and intrinsic coordinates are introduced in terms of which there exist many-body wave functions separable into one factor that describes the rotation of the system as a whole and another the residual intrinsic structure. (auth)

30948 EFFECT OF DENSITY DEPENDENT N–N FORCES ON 1p SHELL HYPERNUCLEI BINDING ENERGIES. Ho, T. H.; Volkov, A. B. (McMaster Univ., Hamilton, Ont.). Phys. Lett.; 31B: 259-62(2 Mar 1970).

The use of a density dependent NN force reduces the theoretically determined Λ binding energy 1p shell nuclei by approximately 0.2 to 0.4 MeV due to compressibility effects. Different odd state ΛN interactions can change these results. (auth)

30949 ON THE RELATIONSHIP BETWEEN THE LEVEL-STRUCTURES IN SPHERICAL AND DEFORMED NUCLEI. Gneuss, G.; Mosel, U.; Greiner, W. (Univ., Frankfurt am Main). Phys. Lett.; 31B: 269-72(2 Mar 1970).

The systematics of the collective spectra in even–even–nuclei are analyzed by means of a collective model which treats rotations and vibrations in a uniform manner. The theoretical foundation of some previous purely phenomenological level-assignments is clarified. (auth)

30950 SOME GENERAL PROPERTIES OF THREE AND MORE PARTICLE STATES WITH LARGE SPIN. Kharitonov, Yu. I.; Peker, L. K.; Sliv, L. A. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett.; 31B: 277-9(2 Mar 1970).

The properties are considered of the levels arising from splitting of the configuration $\{j^3\}$ caused by residual interactions. The doublet splitting of the $\{j^n sJ,\ j_1 = 1/2\}$-configuration is shown to depend on the strength of singlet forces and to be proportional to $(2J + 1)$. (auth)

30951 FISSION BARRIER AND ODD-MULTIPOLE SHAPE DISTORTIONS. Moeller, P.; Nilsson, S. G. (Univ. of Lund, Sweden). Phys. Lett.; 31B: 283-6(2 Mar 1970).

The effect of the inclusion of both the P_3 and the P_5 degrees of the freedom is describing the potential-energy surface of elements in the lead and actinide region was investigated. An instability is encountered in the actinide region, particularly so for its lighter members. On the other hand the potential-energy surface of ^{210}Po is found to be stable with respect to asymmetric changes of shape at and near the highest fission barrier peak. These features of the static surface are conjectured to be responsible for the mass distribution of the fission fragments. (auth)

30952 EFFECTS OF COMPOUND-NUCLEUS LIFETIME ON BLOCKING DIPS. (A MONTE CARLO CALCULATION). Massa, I. (Univ., Bologna). Lett. Nuovo Cim.; 3: 186-91(5 Feb 1970).

The Monte Carlo method is used to find a characteristic parameter sensitive to the mean lifetime of the compound nucleus originating from the motion of a charged particle through a monocrystal. The reaction $p + {}^{107}Ag \rightarrow {}^{108}Cd \rightarrow \alpha + {}^{104}Pd$ is considered. (L.W.A.)

30953 RELATIVISTIC GENERALIZATION FOR THE FORM FACTOR OF A FEW-PARTICLE SYSTEM. Cocho, G.; Flores, J. (Univ. Nacional Autonoma de Mexico, Mexico City). Phys. Lett., 31B: 639-42(11 May 1970).

Assuming that the relative motion between the particle in the nucleus is non-relativistic, using the methods of group theory, a relativistic generalization for the charge form factor of a few-nucleon system is proposed, which is useful for very high values of the momentum transfer. The formalism is applied to the three-nucleon system. (auth)

30954 DIRECT TWO-NUCLEON TRANSFER REACTIONS AND THEIR INTERPRETATION IN TERMS OF THE NUCLEAR SHELL MODEL. Towner, I. S. (Nuclear Physics Lab., Oxford); Hardy, J. C. Advan. Phys.; 18: 401-3(Jul 1969).

The distorted wave Born approximation (DWBA) treatment for direct two-nucleon transfer reactions has been derived following the formalism of Satchler (1964 and 1966), spin-orbit coupling being included in the distorted wave expansions. Methods for the evaluation of the integrals involved are described, and in particular a discussion is given of two different "zero-range" approximations, one involving an assumption that the heaviest projectile has zero extent, the other assuming the interaction to have zero range. These two approaches are compared. The main emphasis, however, is directed towards extracting from experimental two-nucleon transfer reactions, reliable spectroscopic information, and to this end, shell model expressions for the spectroscopic amplitude have been derived, together with closed formulae for two-particle coefficients of fractional parentage (cfp). The JT representation is used principally throughout, but expressions are given for the LSJT representation as well as for the separate treatment of neutrons and protons. Examples illustrating (i) excitation of analogue states; (ii) comparison of (p,t) and (p, ^{3}He) reactions to mirror states; and (iii) coherence effects between different shell model orbitals, indicate the usefulness of two-nucleon transfer reactions in determining nuclear structure information such as spins, parities, two-body matrix elements, etc. As a further aid to the analysis of experimental data, numerical tables of two-particle cfp's in the isospin formalism for j = $\frac{1}{2}$, $\frac{3}{2}$ and $\frac{5}{2}$ are given for states of low seniority, and in the non-isospin formalism for j = $\frac{1}{2}$, $\frac{3}{2}$, $\frac{5}{2}$ and $\frac{9}{2}$ shells. (auth) (UK)

30955 TRANSCRIPTION OF THE QUASI PARTICLE IN THE IDEAL SPACE. Banville, M.; Simard, P. A. (Univ. of Sherbrooke, Quebec). Can. J. Phys.; 48: 819-26(1 Apr 1970). (In French).

The transcription of the quasi-particle in the ideal space was studied in such a way that all terms in the Hamiltonian in the QTD approximation for the system of four quasi-particles can be found. It is found that an infinity of solutions exists which verify the commutator $\{\alpha,\alpha^+\}$ while yielding correct Hamiltonian matrix elements. Finally, particular solutions which do not verify this commutator are found. Their particular invariance properties under canonical transformations make them relatively easy to obtain. Nonphysical states are eliminated by these transcriptions and all the physical states appear properly antisymmetrized. (auth) (Canada)

30956 PERTURBATION THEORY FOR THE THREE-NUCLEON SYSTEM. Yaes, Robert J. (Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI; No. 305, 1-29(1969).

Perturbation techniques which were developed in a previous paper are applied to the three nucleon system as described by the integral equations of Aaron, Amado and Yam. A local-central, proton-proton potential and the proton-neutron mass difference are introduced as perturbations and it is shown that integral equations of the same form as the Aaron, Amado and Yam equations will result. An expression is obtained for the shift in the energy of the three nucleon bound state in terms of the shift in the kernel of the integral equation and the bound state wave functions. It is shown that the contribution of the perturbing potential to the energy shift is just its expectation value. The contribution of the p−n mass difference to the ^{3}He−^{3}H binding energy difference is estimated and found to be of the order of magnitude of 10^{-3} MeV, and it is concluded that it can be neglected in comparison with the observed energy difference of 0.76 MeV. (auth) (Finland)

30957 REALISTIC RESIDUAL INTERACTION IN FINITE NUCLEI. Lee, Paul Hoong Chien. Montreal; McGill Univ. (1969).

Thesis.

The nuclear reaction matrix, or the residual interaction between valence particles is defined in terms of the nucleon-nucleon potential in the context of the nuclear shell model. A non-local but separable potential is constructed to fit the most recent nucleon-nucleon scattering phase-parameters. This potential as well as several other similar potentials are used to calculate the reaction matrix elements in the 1s-0d shell for mass 18 nuclei. The effect of the Pauli principle is treated exactly as well as in various approximations. The spectrum for intermediate states is taken to be that provided by the single-particle harmonic oscillator potential or that of free particles. In either case the bound or occupied levels are described by oscillator wave functions. For each intermediate spectrum the results are compared to those obtained for the local, hard-core potential of Hamada and Johnston. A free reaction matrix is calculated for the separable potential. It is shown that by suitably choosing the value of one energy-like parameter in the free reaction matrix, it can reproduce matrix elements of the nuclear reaction matrix. The former has a semi-analytical form and can be very conveniently used for complicated nuclear structure calculations. (Disser. Abstr. Int., B)

30958 A METHOD FOR THE ANALYSIS OF EXPONENTIAL DECAY CURVES. Paatero, Pentti (Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A IV; No. 319, 1-60(1969).

The method presented can be used for the analysis of different kinds of measured distributions, by the use of different response matrices. Linearization of the nonlinear problem of determination of the decay constants is achieved by selecting a set or "grid" of fixed half-lives (previous information about the solution can and should be utilized in this selection); the measured decay curve is expressed as a sum with non-negative coefficients of exponentials with these half-lives. A computer subroutine is presented for the performance of this fit. The subroutine is general and can be used in the analysis of all kinds of measurements; for a complete program, about 4,000 to 8,000 words of computer memory are required. A discussion is given of different possibilities of error: systematic, statistical, and component identification. Explicit expressions are presented, in terms of the covariance matrix of the fit, for the systematic and statistical errors of the results produced by the method, along with numerical examples. A measurement of the decay of ^{129}Ba is analyzed as an example. (auth) (Finland)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 29990, 31037, 31051, and 31082.

30959 IRRADIATION OF TEST FUEL ELEMENTS WITH THIN-WALLED STEEL CLADDING IN A CO_2-LOOP. Jung, W.; Knaab, H.; Stehle, H. (Siemens Aktiengesellschaft, Erlangen, Ger.). Atompraxis; 16: 82; 85-93(Mar-Apr 1970). (In German).

Four irradiations, forming a final inpile test program of the KKN fuel element, were performed in the BR2-reactor at Mol/Belgium. The test fuel elements were composed of seven original KKN fuel rods each and a structure similar to the original. Irradiation conditions conformed to original and more severe conditions. No incidents have been noted. Post-irradiation examinations performed in the hot cells at Erlangen gave positive results with respect to deformations and metallurgical performance of the rods as well as to the interaction between structure and rods. Thus, the performance of the fuel element under designed KKN-conditions could be demonstrated. The evaluation of the longtime burnup performance, however, can be based only on KKN first-core experience. (13 references) (auth)

30960 SPAIN'S FIRST NUCLEAR POWER STATION. Voysey, A. E. Atompraxis; 16: 108-10(Mar-Apr 1970).

The construction of the Zorita Power Reactor is described. Design parameters are listed. (D.C.C.)

30961 TRANSPORT TRIUMPH AT ZORITA. Leigh, L.; Mac-Veigh Alfos, T.; Gudin, E. U. (Westinghouse Electric International Co., New York). Atompraxis; 16: 111-14(Mar-Apr 1970).

Spain's first nuclear power plant is due for completion in July. A primary problem, transportation of three huge pieces of equipment for the 160 MW plant, was solved by a special split rail car with 20 axles, in which the load could move 30 cm sideways and 24 cm up or down. A floating sheerleg crane disembarked the equipment at Cartagena, the rail car transported it to Taracon and there, a gigantic highway two railer with four tractors took over for the final stage to Zorita. (auth)

30962 ADVANCED DESIGN CONCEPTS IN NUCLEAR POWER PLANTS: BRITAIN'S LATEST AGR. Drakes, D. F. (British Nuclear Design and Construction Ltd., Leicester, Eng.). Atompraxis; 16: 114-16(Mar-Apr 1970).

The 1250 MW twin-reactor nuclear power station under construction at Hartlepool is described. The main design and construction features are presented. The station is designed on the unit principle with each of the two reactors connected to its associated turbo-generators. A key feature is a reactor layout using standardized, factory built and tested boilers inserted in nine foot (2.7 m) diameter vertical steel-lined and insulated shafts in the wall of the pressure vessel. They are of the "once through" type and coupled in pairs on the steam and feedwater sides to operate as four separate steam generators. The compact centrifugal gas circulator used for this station is a further development of the type used in Britain's Windscale prototype AGR. The core design embodies the Windscale re-entrant flow principle and is constructed of isotropic graphite and mounted on supports that spread the load over the base of the vessel. A single on-load fuelling machine serves both reactors. (auth)

30963 CONSTRUCTION OF THE NUCLEAR POWER PLANT IN VANDELLOS. Buttin, J. (Societe pour l'Industrie Atomique, Paris). Atompraxis; 16: 120-2(Mar-Apr 1970). (In German).

The French constructor group is building in Vandellos (Spain) a complete nuclear power plant of 500 MW(e). This plant is of the EDF-Saint-Laurent-des-Eaux type, slightly modified according to local conditions. (auth)

30964 CHANGE IN THE STRUCTURE OF THE ELECTRICITY SUPPLY INDUSTRY DUE TO THE USE OF NUCLEAR POWER STATIONS. Frewer, Hans-Heinrich (Kraftwerk Union AG, Muelheim, Ger.). At. Strom; 16: 46-52(Mar-Apr 1970). (In German).

In the German Federal Republic development of the peaceful uses of nuclear energy has now entered the commercial phase. After a short account of developments in other countries, the situation in the Federal Republic which led to the foundation of the Kraftwerk Union is reviewed. An explanation follows of the types of reactors in the Federal Republic and in other countries. Special attention is paid to economic efficiency. Finally, the outlook for the change in structure of the electricity supply industry, which has already begun, is discussed. (auth)

30965 PRELICENSING ANTITRUST REVIEW OF NUCLEAR POWERPLANTS. PART 1. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-FIRST CONGRESS, FIRST SESSION, NOVEMBER 18, 19, AND 20, 1969. Washington, D. C.: Joint Committee on Atomic Energy (1970). 319p. GPO $1.25.

Included are the JCAE hearings and supporting documentation concerning several bills dealing with U. S. power reactors. The various legislative proposals discussed would eliminate from the Atomic Energy Act of 1954 the requirement that a finding of practical value be made for nuclear power plants before they may be licensed as commercial facilities. The effect of the proposals would be that nuclear power plants would be subject to a prelicensing antitrust review. One of the proposed bills would also delegate to the AEC regulatory authority to control the thermal effects of heated liquid effluents discharged from power plants. (H.D.R.)

30966 NUCLEAR ENERGY IN THE GERMAN DEMOCRATIC REPUBLIC. Lavrencic, Devana; Sansone, M. Magda. Com. Naz. Energ. Nucl., Notiz.; 16: No. 4, 52-8(Apr 1970). (In Italian).

A review of the nuclear organizations and activities in the German Democratic Republic is presented. The main research centers and facilities, the power generation program, and in particular the Rheinsberg Power Plant are described. (auth)

30967 STUDIES SHOW NEED FOR THERMAL-EFFECT DATA. Powell, C. J. Elec. World; 172: 26-8(8 Sep 1969).

Studies on the effects of Paradise and Browns Ferry power stations' cooling water discharges on aquatic life and ways to control thermal discharges are discussed. (Fuel Abstr.)

30968 THE NUCLEAR POWER STATION BUGEY 1. PART I. DIRECTING IDEAS AND CONCEPTUAL CHARACTERISTICS. Robert, E. (Electricite de France, Paris). Energ. Nucl. (Paris); 11: 197-207(Jun 1969). (In French).

A new approach was made in the design of the Bugey I reactor in which annular fuel elements cooled internally and externally were used. The characteristics of this experimental reactor are tabulated, and the preliminary studies made prior to the design of the Bugey I were described. These centered on the retention of the integrated primary loop, a better utilization of the fuel, increase of the flexibility of the materials, and increase of the operational safety. The program of these preliminary studies on the fuel, graphite core configuration, prestressed reactor vessel, handling of the fuel, and operation and safety are outlined. The preliminary studies on Bugey I are discussed. (J.S.R.)

30969 THE NUCLEAR POWER STATION BUGEY 1. PART II. THE REACTOR VESSEL AND ITS FOUNDATIONS. Soulier, L.; Malaval, P. (Electricite de France, Paris). Energ. Nucl. (Paris); 11: 208-18(Jun 1969). (In French).

The general characteristics of the reactor vessel and basic calculation criteria are outlined, and total verification mock-ups were constructed. Preliminary studies on the foundations for the reactor vessel showed that the most economic was a square frame strengthened by a peripheral wall. The framework and its construction are described. The vessel itself is in the form of a cylinder with vertical axis. The metallic and concrete parts of the vessel are discussed. The instrumentation included in the construction of the vessel is described. (J.S.R.)

30970 THE NUCLEAR POWER STATION BUGEY 1. PART III. THE CORE AND SUPPORTING STRUCTURES. Rodet, E.; Aspord, J.-M. (Electricite de France, Paris). Energ. Nucl. (Paris); 11: 219-23(Jun 1969). (In French).

The core is an assemblage of graphite bricks, constituting a vertical cylinder with circular cross section enclosed at its periphery by a steel ring and covered externally by steel. The core and its supporting structures are described. The core support plate is similar to that of the reactor at Saint-Laurent-des-Eaux, as are the structure and supports concealing the reactor fuel elements and the support plate. (J.S.R.)

30971 THE NUCLEAR POWER PLANT BUGEY 1. PART IX. THE DIRECTION OF THE CONSTRUCTION AND THE EXECUTION OF THE WORK. Sevin, Philippe; Bonnelle, Robert; Boissonnet, Bernard (Electricite de France, Paris). Energ. Nucl. (Paris); 11: 253-60(Jun 1969). (In French).

The construction schedule of the Bugey I power plant is outlined.

The preliminary work in the preparation of the site is indicated, and the excavation, construction of the containment vessel, and construction of the foundations are described. The installation of the handling devices and gantries is considered. The construction of the reactor vessel is outlined with a discussion of the quality control. Particular features of the heat exchangers are considered briefly. (J.S.R.)

30972 THE NUCLEAR POWER PLANT BUGEY 1. PART VIII. THE CONTROL SYSTEM OF BUGEY 1. Morin; Baudry (Electricite de France, Paris). Energ. Nucl. (Paris); 11: 246-52(Jun 1969). (In French).

The Bugey I power plant is operated from a unique control room by a single operator. This type of operation requires considerable automation of the control system. The functional structures and the organization principles of the automation are analyzed. The development of the automatic equipment and the role of computers in the reactor operation are discussed. The means of information and of action given by the computers during the operation are described, and the configuration of the computers is outlined. The coordination of all these constituents in the command control of the reactor is described. (J.S.R.)

30973 THE NUCLEAR POWER PLANT BUGEY 1. PART VII. PURIFICATION OF THE CO_2. Rodet, E.; Baret, J.-P. (Electricite de France, Paris). Energ. Nucl. (Paris); 11: 243-5(Jun 1969). (In French).

The corrosion resistance of graphite and the use of methane as a corrosion inhibitor are described. The purpose of the installations for processing of the CO_2 is to assure the injection of methane, to remove from the interior of the vessel a part of the CO_2 in order to purify it, to assure the CO_2 feed to some auxiliaries, and to dry the vessel during shut-down after admission of air into the vessel. The design and operational principle of the CO_2 purification installations for the Bugey I are described. The characteristics of the principal materials used in their construction are outlined. (J.S.R.)

30974 THE NUCLEAR POWER PLANT BUGEY 1. PART VI. THE CO_2 CIRCUIT-BLOWERS. Cazemajou, C.; Ampeau, P. (Electricite de France, Paris). Energ. Nucl. (Paris); 11: 238-42(Jun 1969). (In French).

The pressurized circulation of the CO_2 in the natural-uranium graphite reactor is assured by groups of blowers. The blower characteristics considered during the preliminary studies are outlined, and the choice made is justified. The principal characteristics of the blowers and turbines are described. Devices peculiar to the turbine and to the blower are discussed. Provisions made to assure integrity of the loop are indicated. (J.S.R.)

30975 THE NUCLEAR POWER STATION BUGEY 1. PART V. THE WATER-STEAM CIRCUIT AND THE HEAT EXCHANGER. Cazemajou, C.; Chaney, H. (Electricite de France, Paris). Energ. Nucl. (Paris); 11: 229-37(Jun 1969). (In French).

In gas-cooled uranium graphite reactors, the primary loop contains CO_2 and transfers the heat from the reactor to heat exchangers. The secondary loop, through a heat exchanger, generates steam to produce mechanical energy in the steam turbines. The selection of the thermodynamic cycle for the water-steam loop for the Bugey I is described. The factors leading to the selection of the water-steam flowsheet are outlined and the flowsheet is described. The heat exchangers are integrated in the primary loop and a detailed description of them is given. The processing of the water and degassing procedures are described. (J.S.R.)

30976 THE NUCLEAR POWER STATION BUGEY 1. PART IV. FUEL MANAGEMENT. Rodet, E.; de Vivies, P. Martin (Electricite de France, Paris). Energ. Nucl. (Paris); 11: 224-8 (Jun 1969). (In French).

The design and operation of the loading machine for the Bugey I Reactor is described. Special design feature of the fuel elements is given. (J.M.J.)

30977 CHINON I. HUMAN PENETRATION INTO A REACTOR AFTER 24,000 HOURS OF POWER OPERATION. Rateau, M.; Simon, H. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 78, 19-31(Jul-Aug 1969). (In French).

During a routine television examination of the support plates of the reactor during shutdown, metal debris was observed. Further inspections showed that this debris was from the deflector. Radiation level was 3 R/hr of γ and 10 fast neutrons/cm^2/sec; temperature was 60 to 70°C. The preparations made for human penetration, the entry, and the repair work were described in detail. The repair work lasted for 21 days as the men were limited to 1½ hrs exposure per day. Each penetration was made with a well-prepared work plan. The integrated doses for the personnel did not pass excessive limits. (J.S.R.)

30978 COOLING THE HOT CIRCUITS OF THE VANDELLOS NUCLEAR POWER PLANT BY SEA WATER. Kammerlocher, M. L. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 78, 32-42(Jul-Aug 199). (In French).

The results of a short-term experiment on the protection of the structures and materials of the circuits of the Vandellos nuclear power plant exposed to sea water are reported. A test facility using sea water and saline air was built and studies were made on the materials and structures of the Vandellos power plant. Samples were treated to periodic injections in the water of chlorine water or were covered with an electrolytic deposit of iron oxide. The structures with chlorine water injection showed the least attack, but the danger of too strong concentrations of Cl_2 on the cupro-aluminum was established. The tubular bundles were protected by continuous electrolytic deposition of a protective layer or by periodic injections of ferrous sulfate. The results indicated that the best solution for the protection of tubular bundles was an installation for the periodic injection of ferrous sulfate. The effects of sea water on various paints and adhesives were also studied. (J.S.R.)

Operation and Economics

30979 (AI-AEC-12832) RETIREMENT OF THE PIQUA NUCLEAR POWER FACILITY. Wheelock, C. W. (Atomics International, Canoga Park, Calif.). 1 Apr 1970. Contract AT(11-1)-1767. 74p. Dep. CFSTI.

Conditions, requirements, and actions involved in the retirement program for the Piqua Power Reactor are described. 13 references. (D.C.C.)

30980 (CVNA-281) CAROLINAS VIRGINIA TUBE REACTOR SUMMARY REPORT. Willoughby II, W.; Alligood, F. M. Jr.; Barrow, W. E.; Jones, M. B. Jr.; Kortheuer, J. D.; Moore, W. E. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). Jun 1967. Contract AT(30-1)-2289. 254p. Dep. CFSTI.

The CVTR was a heavy water cooled and moderated pressure tube design for a power reactor. The reactor went critical March 31, 1963, initial power operation began on December 16, 1963, commercial power operation began on May 1, 1964, and power operation terminated on January 24, 1967. The power level was raised from 44.3 to 65 MW in September 1965. During the entire period of commercial operation the plant gave good performance and overall availability through January 1967 was 78.14%. Summaries are presented in separate sections on: (1) the Pre-construction Research and Development Program; (2) the important design features of the reactor; (3) CVTR aspects as a large-plant prototype; (4) the Post Construction Research and Development Program; (5) the operating experience; and (6) a list of 295 reports published for the CVTR by Carolinas-Virginia Nuclear Power Associates. (15 references) (H.D.R.)

30981 (DOCKET-50130-5) PATHFINDER GENERATING PLANT, SIOUX FALLS, SOUTH DAKOTA. License No. DPR-11. Six-Month Operating Report No. 8. Plant Operating Experience, November 14, 1969-May 14, 1970. (Northern States Power Co., Minneapolis, Minn.). 22 May 1970. 8p. (NSP-7001). Dep. CFSTI.

30982 (DOCKET-50219-77) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 57. (Jersey Central Power and Light Co., Morristown, N. J.). 2 Jun 1970. 28p. Dep. CFSTI.

Revised safety limits are described. Testing programs and requirements are presented. Operations during January to March 1970 are revised. (D.C.C.)

30983 (TID-25430) PHYSICS PERFORMANCE OF SHIPPINGPORT. Flanagan, C. A. (Bettis Atomic Power Lab., West Mifflin, Pa.). [1969]. 44p. Dep. CFSTI.

The physics performance of Shippingport Core 2 operations from initial startup of the first seed through initial power operations on the second seed is summarized. The emphasis is on comparison of observed results with calculated results to identify the ability of current calculational techniques to describe core operations. Also included are selected comparisons of results of isotopic examination programs performed on Core 1 seed and blanket fuel assemblies. The comparisons indicate that critical core configurations are described with varying degrees of success with reactivity deviations generally less than 1% $\Delta\rho$. Power distributions agree reasonably well with measured values. Results of destructive analysis programs indicate that both gross and local fuel depletion are calculated to within 5 to 10%. 14 references. (auth)

30984 DECOMMISSIONING HALLAM. Ureda, B.; Heine, W. F. (Atomics International, Canoga Park, Calif.). Nucl. News; 13: No. 6, 40-5; 48(Jun 1970).

The problems, considerations, and solutions involved in decommissioning the Hallam Nuclear Power Facility are described. (H.D.R.)

30985 DECOMMISSIONING CVTR. Willoughby II, W.; Babb, H. T. (Carolinas Virginia Nuclear Power Associates, Inc., Columbia, S. C. South Carolina Electric and Gas Co., Columbia, S. C.). Nucl. News; 13: No. 6, 48-51(Jun 1970).

The considerations, problems, and solutions involved in decommissioning the Carolinas–Virginia Tube Reactor are described. (H.D.R.)

30986 DECOMMISSIONING BONUS. Iriarte, Modesto Jr.; Hernandez-Fragoso, J. (Electrical Planning, Research, and Construction, San Juan, Puerto Rico). Nucl. News; 13: No. 6, 51-6(Jun 1970).

The considerations, problems, and solutions involved in decommissioning the Boiling Nuclear Superheater Power Station are described. (H.D.R.)

30987 DECOMMISSIONING PATHFINDER. Bjeldanes, M. N. (Northern States Power Co., Minneapolis). Nucl. News; 13: No. 6, 56-8(Jun 1970).

The considerations, problems, and solutions involved in converting the Pathfinder nuclear power plant to a fossil-fueled system are described. (H.D.R.)

Safety and Siting

30988 (DOCKET-1155-37) LA CROSSE BOILING WATER REACTOR. Malfunction of the Turbine Main Steam Bypass Valve System. Incident Report No. DPC-70-3. (Dairyland Power Cooperative. La Crosse, Wis.). 5 Jun 1970. 9p. Dep. CFSTI.

30989 (DOCKET-1155-38) LA CROSSE BOILING WATER REACTOR. Loss of Load From 55 Percent Power. Power Test No. DPC-2. (Dairyland Power Cooperative, La Crosse, Wis.). 10 Jun 1970. 9p. (DPC-851-9). Dep. CFSTI.

30990 (DOCKET-50003-41) INDIAN POINT STATION, UNIT NO. 1. Failure of Thermal Sleeve. (Consolidated Edison Co. of New York, Inc.. New York). 28 May 1970. 8p. Dep. CFSTI.

30991 (DOCKET-50003-42) INDIAN POINT STATION, UNIT NO. 1. Decay Heat Cooling System Design Modification. (Consolidated Edison Co. of New York, Inc., New York). 3 Jun 1970. 19p. Dep. CFSTI.

30992 (DOCKET-50003-43) INDIAN POINT STATION, UNIT NO. 1. Modification of Decay Heat Cooling System. (Division of Reactor Licensing (AEC), Washington, D. C.). 5 Jun 1970. 2p. Dep. CFSTI.

30993 (DOCKET-50016-39) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Request for Technical Specifications Change No. 21. (Power Reactor Development Co., Detroit, Mich.). 10 Jun 1970. 60p. Dep. CFSTI.

Revised information on predicted Core A fuel assembly performance is presented. Burnup limits are specified for the core fuel alloy and blanket fuel alloy. (D.C.C.)

30994 (DOCKET-50219-75) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Control Rod Drives. (Jersey Central Power and Light Co., Morristown, N. J.). 2 Jun 1970. 7p. Dep. CFSTI.

Cold and hot scram times and stall flows are listed for the control rod drives. (D.C.C.)

30995 (DOCKET-50219-76) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Main Steam Isolation Valves. (Jersey Central Power and Light Co., Morristown, N. J.). 3 Jun 1970. 7p. Dep. CFSTI.

Leak testing procedures and results for the main steam isolation valves are presented. (D.C.C.)

30996 (DOCKET-50237-47) DRESDEN NUCLEAR POWER STATION, UNIT 2. Abnormal Occurrence Report: HPCI Steam Line Displaced. (Commonwealth Edison Co., Chicago, Ill.). 2 Jun 1970. 2p. Dep. CFSTI.

30997 (DOCKET-50237-48) DRESDEN NUCLEAR POWER STATION, UNIT 2. Technical Specifications Safety Evaluation of Change No. 1. (Division of Reactor Licensing (AEC), Washington, D. C.). 4 Jun 1970. 5p. Dep. CFSTI.

Revised safety limits for fuel cladding to include operation at 5% coolant flow are presented. (D.C.C.)

30998 (DOCKET-50237-49) DRESDEN NUCLEAR POWER STATION, UNIT 2. Failure of Electromatic Relief Valve to Open. (Commonwealth Edison Co., Chicago, Ill.). 8 Jun 1970. 2p. Dep. CFSTI.

30999 (DOCKET-50244-43) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Technical Specifications, Change No. 3. (Rochester Gas and Electric Corp., N. Y.). 28 May 1970. 5p. Dep. CFSTI.

Surveillance requirements for the residual heat removal pumps and containment spray pumps are presented. (D.C.C.)

31000 (DOCKET-50245-33) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 25. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). 2 Jun 1970. 41p. Dep. CFSTI.

Modifications for the cooling system and pressure vessel internal cladding are described. Removal and cladding procedures for furnace-sensitized stainless steel components are reviewed. (D.C.C.)

31001 (DOCKET-50245-34) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 26. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). 9 Jun 1970. 3p. Dep. CFSTI.

Cladding and replacement requirements for furnace-sensitized stainless steel cooling system components are described. (D.C.C.)

31002 (DOCKET-50247-35) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Preliminary Safety Analysis Report, Amendment 18 (Includes Final Facility Description and Safety Analysis Report, Suppl. 9. (Consolidated Edison Co. of New York, Inc., New York). 3 Jun 1970. 171p. Dep. CFSTI.

The corrosive effects of the ECCS solution on reactor core components and the pressure vessel are analyzed. Dose calculations for fuel handling accidents are listed. Seismic stress analysis of the containment structure is presented. (D.C.C.)

31003 (DOCKET-50259-11) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Environmental Radioactivity Levels. Semiannual Report, July–December 1969. (Tennessee Valley Authority, Chattanooga. Office of Power). 3 Jun 1970. 30p. (DOCKET-50260-11; DOCKET-50296-11). Dep. CFSTI.

31004 (DOCKET-50261-31) H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2. Statement on the Environmental Considerations Related to the Proposed Operation by Carolina Power and Light Company. (Division of Reactor Licensing (AEC), Washington, D. C.). 5 Jun 1970. 13p. Dep. CFSTI.

Information concerning the radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

31005 (DOCKET-50261-32) H. B. ROBINSON UNIT NO. 2 SITE. Pre-Operational Environmental Monitoring. 1969 Annual Report. (NUS Corp., Rockville, Md.). 26 May 1970. 49p. (NUS-673). Dep. CFSTI.

31006 (DOCKET-50261-33) H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2. Tendon Analysis Report. (Carolina Power and Light Co., Raleigh, N. C.). 5 Jun 1970. 27p. Dep. CFSTI.

31007 (DOCKET-50261-34) H. B. ROBINSON UNIT NO. 2. Likelihood and Consequences of Turbine Overspeed. (Carolina Power and Light Co., Raleigh, N. C.). 5 Jun 1970. 61p. Dep. CFSTI.

31008 (DOCKET-50261-35) H. B. ROBINSON UNIT NO. 2. Additional Information Concerning Seismic Analysis of Class I Piping and Equipment. (Carolina Power and Light Co., Raleigh, N. C.). 5 Jun 1970. 60p. Dep. CFSTI.

31009 (DOCKET-50266-21) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 8. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). 5 Jun 1970. 47p. (DOCKET-50301-18). Dep. CFSTI.

Financial data on the owners of Point Beach Power Reactor Units 1 and 2 are presented in support of the application for operating license. The 1969 Annual Reports for the Wisconsin Electric Power Company and the Wisconsin Michigan Power Company are included. (D.C.C.)

31010 (DOCKET-50312-16) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1. Supplemental Information on Containment. (Sacramento Municipal Utility District, Calif.). 30 May 1970. 7p. Dep. CFSTI.

31011 (DOCKET-50322-19) SHOREHAM NUCLEAR POWER STATION, UNIT NO. 1. Environmental Statement. (Long Island Lighting Co., Mineola, N. Y.). 1 Jun 1970. 95p. Dep. CFSTI.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Site characteristics are described. (D.C.C.)

31012 (DOCKET-50328-18) SEQUOYAH NUCLEAR PLANT, UNIT 2. Provisional Construction Permit No. CPPR-73. (Division of Reactor Licensing (AEC), Washington, D. C.). [nd]. 2p. Dep. CFSTI.

31013 (DOCKET-50329-14) MIDLAND PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 12. (Consumers Power Co., Jackson, Mich.). 28 May 1970. 10p. (DOCKET-50330-14). Dep. CFSTI.

Additional information on pressure vessel integrity, hazardous chlorine release possibilities, and site characteristics is presented. Revised information on the high-pressure level alarm integrity is included. (D.C.C.)

31014 (DOCKET-50329-15) MIDLAND PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 13. (Consumers Power Co., Jackson, Mich.). 2 Jun 1970. 43p. (DOCKET-50330-15). Dep. CFSTI.

Financial data on the owners of the Midland Power Reactor Units 1 and 2 are presented in support of the application for construction permit and operating license. The 1969 Annual Report for the Consumers Power Company is included. (D.C.C.)

31015 (DOCKET-50335-15) HUTCHINSON ISLAND PLANT, UNIT NO. 1. Environmental Considerations in the Proposed Construction and Operation. (Division of Reactor Licensing (AEC), Washington, D. C.). 4 Jun 1970. 8p. Dep. CFSTI.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

31016 (DOCKET-50336-15) MILLSTONE NUCLEAR POWER STATION, UNIT 2. Environmental Statement. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). 10 Jun 1970. 85p. Dep. CFSTI.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

31017 (DOCKET-50341-11) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 5. (Detroit Edison Co., Mich.). 5 Jun 1970. 27p. Dep. CFSTI.

Seismic stress analysis for Class 1 equipment and structures is presented. Missile generation possibilities for the turbines are analyzed. (D.C.C.)

31018 (DOCKET-50344-10) TROJAN NUCLEAR PLANT. Information Required by National Environmental Policy Act. (Portland General Electric Co., Oreg.). 29 May 1970. 11p. Dep. CFSTI.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

31019 (DOCKET-50361-1) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Application for Construction Permit. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 28 May 1970. 111p. (DOCKET-50362-1). Dep. CFSTI.

Financial data on the owners of the San Onofre Power Reactor Units 2 and 3 are presented in support of the application for construction permit. The 1969 Annual Reports for Southern California Edison Company and the San Diego Gas and Electric Company are included. The effects of the proposed reactors on the environment are analyzed. (D.C.C.)

31020 (DOCKET-50361-2) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Vol. 1. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 28 May 1970. 370p. (DOCKET-50362-2). Dep. CFSTI.

Information is presented on San Onofre Power Reactor Units 2 and 3 under the following headings: introduction; principal architectural and engineering criteria for design; design characteristics and highlights; identification and qualifications of applicants and contractors; the general information and design criteria. (D.C.C.)

31021 (DOCKET-50361-3) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Vol. 2. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 28 May 1970. 426p. (DOCKET-50362-3). Dep. CFSTI.

Information is presented on San Onofre Power Reactor Units 2 and 3 under the following main headings: site and environment; and reactor. (D.C.C.)

31022 (DOCKET-50361-4) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Vol. 3. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 28 May 1970. 504p. (DOCKET-50362-4). Dep. CFSTI.

Information is presented on San Onofre Power Reactor Units 2 and 3 under the following main headings: reactor coolant system; containment and structures; engineered safety features; instrumentation and control; electrical system; auxiliary and emergency systems; and steam and power conversion system. (D.C.C.)

31023 (DOCKET-50361-5) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Vol. 4. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 28 May 1970. 646p. (DOCKET-50362-5). Dep. CFSTI.

Information on San Onofre Power Reactor Units 2 and 3 is presented under the following main headings: radioactive waste disposal and radiation protection; conduct of operations; initial tests and operation; safety analyses; and technical specifications. Appendices contain information on: quality program; design bases for structures, systems, and equipment; functional evaluation of components of system shared by two units; effects of construction on operating units; and proposed in-service inspection program for Units 2 and 3. (D.C.C.)

31024 (DOCKET-50363-1) FORKED RIVER NUCLEAR GENERATING STATION, UNIT NO. 1. Application for Construction Permit and Operating License. (Jersey Central Power and Light Co., Morristown, N. J.). 1 Jun 1970. 48p. Dep. CFSTI.

Financial data on the owners of the Forked River Power Reactor Unit 1 are presented in support of the application for construction permit and operating license. The 1969 Annual Report for the Jersey Central Power and Light Company and the General Public Utilities Corporation is included. (D.C.C.)

31025 (DOCKET-50363-2) FORKED RIVER NUCLEAR GENERATING STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Vol. 1. (Jersey Central Power and Light Co., Morristown, N. J.). 1 Jun 1970. 489p. Dep. CFSTI.

Information on Forked River Power Reactor Unit 1 is presented under the following main headings: introduction and summary; and site and environment. (D.C.C.)

31026 (DOCKET-50363-3) FORKED RIVER NUCLEAR GENERATING STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Vol. 2. (Jersey Central Power and Light Co., Morristown. N. J.). 1 Jun 1970. 296p. Dep. CFSTI.

Information is presented on the Forked River Power Reactor Unit 1 under the following main headings: flood level studies; environmental studies; reactor; and reactor coolant system. (D.C.C.)

31027 (DOCKET-50363-4) FORKED RIVER NUCLEAR GENERATING STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Vol. 3. (Jersey Central Power and Light Co., Morristown, N. J.). 1 Jun 1970. 350p. Dep. CFSTI.

Information on Forked River Power Reactor Unit 1 is presented under the following main headings: containment system; engineered safety features; instrumentation and control; electrical systems; auxiliary systems; steam and power conversion system. (D.C.C.)

31028 (DOCKET-50363-5) FORKED RIVER NUCLEAR GENERATING STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Vol. 4. (Jersey Central Power and Light Co., Morristown, N. J.). 1 Jun 1970. 257p. Dep. CFSTI.

Information on Forked River Power Reactor Unit 1 is presented under the following main headings: waste management and radiation; conduct of operations; initial tests and operations; safety analyses; and technical specifications. (D.C.C.)

31029 (SZS-18/69) REGULATIONS FOR THE HANDLING AND THE WORK WITH SOURCES OF IONIZING RADIATION. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Dec 1969. 34p. (In German). Dep. CFSTI (U. S. Sales Only).

Included are a compilation of regulations and standards in the field of radiation protection legal in the G. D. R., the Ordinance on

Licensing of Nuclear Plants in full text, and a paper on damages caused by radioactive substances or by the operation of nuclear plants with regard to insurance problems. Separate abstracts were prepared for the ordinance on licensing and for the paper on liability for damages. (H.D.R.)

For abstracts of individual papers see: 31030 and 31031.

31030 (SZS-18/69, pp 9-24) ORDINANCE FOR THE FURNISHING OF RADIATION PROTECTION APPROVAL FOR NUCLEAR INSTALLATIONS. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German).

Legal steps for establishing a nuclear power station in the DDR are outlined, especially with respect to radiation hazards. Emphasized are aspect of site selection, agreements on construction of the installation, requirements for permission to operate the station and procedures for reports concerning permanent operations. Also discussed are legal aspects of alterations in power installations, responsibilities, exceptions to the established laws, and payment of fees. Details are described in an appendix. (H.B.G.)

31031 (SZS-18/69, pp 25-34) ASSIGNMENT OF DAMAGES FROM HANDLING RADIOACTIVE MATERIALS AND FROM OPERATION OF NUCLEAR INSTALLATIONS WITH REGARD TO INSURANCE PROTECTION. Strauss, H.; Iffiaender, G. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German).

Differences in the legal approach between socialistic and capitalistic systems are discussed with respect to possible damages caused by nuclear installations and transportation of radioactive material. Two incidents of radioactive contamination within the DDR are reported. In one of the cases, a few mCi of a long-lived α-emitter contaminated an entire research building, instruments, and personnel. Negligence was considered the cause of the incident. Cost of decontamination amounted to approximately $25,000. An extraordinary incident of similar extent occurred at a clinic handling ^{90}Sr. Cost of decontamination also amounted to approximately $25,000. Legally, a difference is made between radiation incidents caused by elements such as lightning, floods, tornados, fires, earthquakes, or by human actions. As a rule, governmental liability should cover all damages caused by nuclear power stations, while, in the case of handling of radioactive material, private liability may be considered. (H.B.G.)

31032 CONTAINMENT ELECTRICAL PENETRATIONS IN THE SAN ONOFRE AND PRAIRIE ISLAND PLANTS. Verber, Fred (Argonne National Lab., Ill.). Reactor Technol.; 13: 97-108(Spring 1970).

The gastight electrical penetrations for the San Onofre power reactor containment vessel are discussed, including a number of problems that developed during installation of the system and startup and operation of the plant. The design of electrical penetration assemblies for Units 1 and 2 of the Prairie Island plant is described. 6 references. (H.D.R.)

31033 TORNADO CONSIDERATIONS FOR NUCLEAR POWER-PLANT STRUCTURES. Doan, P. L. (United Engineers and Constructors, Inc., Philadelphia). Nucl. Safety; 11: 296-308 (Jul-Aug 1970).

Descriptions of the characteristics of tornadoes are presented that are based on documented information. The nuclear plant lifetime tornado risk is assessed, and mechanistic calculational techniques are presented to determine the effects on plant structures of dynamic wind forces, static pressure differentials, and tornado-generated missiles. Particular attention is given to the effects of the design tornado on the spent-fuel storage pool. Potential loss of water by entrainment, suction, evaporation, and radial pressure differentials is assessed. On the basis of highly conservative assumptions, it is shown that the spent-fuel storage pools of existing light-water reactors are quite adequately designed to ensure safe containment of fission products in the event the design tornado occurs. 23 references. (auth)

31034 SAFETY-RELATED OCCURRENCES REPORTED IN FEBRUARY-MARCH 1970. Casto, W. R. Nucl. Safety; 11: 328-9(Jul-Aug 1970).

31035 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. Nucl. Safety; 11: 346-59(Jul-Aug 1970).

Power Reactor Development

Refer also to abstracts 29427, 30054, and 31124.

31036 (TRG-Report-1925) THE FAST BREEDER REACTOR PROGRAMME IN THE UNITED KINGDOM. Bainbridge, G. R. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Apr 1970. 21p. (CONF-690948-2). Dep. CFSTI (U. S. Sales Only).

From International Survey Course on Economic and Technical Aspects of Nuclear Power Conference, Vienna, Austria.

The fast breeder power reactor program in U.K. is reviewed. Factors related to optimum power reactor development are presented. (D.C.C.)

31037 CONSOLIDATION OF RADIOACTIVE CONCENTRATES IN NUCLEAR POWER PLANTS. Meichsner, O. (AEG-Telefunken, Frankfurt am Main). Atompraxis; 16: 93-6(Mar-Apr 1970). (In German).

Two new procedures employed in AEG/BWR nuclear plants for extra high concentration of weak radioactive liquid waste are described. (auth)

31038 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1971. PART 3. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-FIRST CONGRESS, SECOND SESSION ON CIVILIAN POWER REACTORS, MARCH 11, 1970. Washington, D. C.; Joint Committee on Atomic Energy (1970). 503p. GPO $2.00.

The hearings on the U. S. AEC authorization bill for fiscal year 1971 review the Commission's operating funds and its requests for funds for plant and capital equipment. Part 3 of the hearings, together with supporting documentation, is presented. (H.D.R.)

31039 REACTOR TECHNOLOGY. VOLUME 13, NUMBER 2. One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Washington, D. C.; Atomic Energy Commission (Spring 1970). 96p. GPO $0.75.

Included are 6 articles on recent developments in nuclear reactor components, systems, and materials, and on reactor operating experience. A separate abstract was prepared for each article. (H.D.R.)

For abstracts of individual papers see: 29930, 29965, 31032, 31047, 31061, and 31084.

31040 FEATURE ADVANCED THERMAL REACTOR DEVELOPMENT MEETING A NEW ASPECT. LARGE-SCALE FACILITY FOR ADVANCED THERMAL REACTOR DEVELOPMENT. Sakata, Hajime; Nakata, Seibei (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 16: No. 2, 39-47(Feb 1970). (In Japanese).

Major research facilities for the development of an advanced thermal reactor in Japan are described, together with the results obtained in some cases. The ATR is a D_2O moderated, boiling light-water cooled reactor, using slightly enriched U as the initial fuel and natural U plus Pu as the subsequent fuels. The two-region criticality facility consists of an inner D_2O region with slightly enriched UO_2 fuel, and an outer light-water region with similar fuel. The D_2O criticality facility is to supplement the two-region one, and is used for the study of nuclear parameters. The high-temperature loop is for the heat-transfer and flow studies of a prototype ATR, to ascertain the soundness of its thermal design. The component test loop is for testing the endurance of prototype fuel-assemblies and pressure tubes in coolant flow. The safety testing facility is used especially for the study of primary-coolant system rupture accidents. (NSA of Japan)

Kinetics and Dynamics

Refer also to abstract 30760.

31041 (BNWL-1381-1) REACTOR PHYSICS QUARTERLY REPORT, JANUARY-MARCH 1970. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. Contract AT(45-1)-1830. 114p. Dep. CFSTI.

AMERICIUM ISOTOPES Am-241 — decay in plutonium oxide (PuO_2)-uranium oxide (UO_2) lattice, effects on reactivity of

CRITICAL ASSEMBLIES — physics measurements in ZPR-3, for FTR mockup

EXPERIMENTAL BREEDER REACTOR-II — fuel pins of, physics measurements for plutonium oxide (PuO_2)-uranium oxide (UO_2)

FAST TEST REACTOR — stability analysis of
— neutron flux in
— shielding requirements for, (E/T)

GENERAL ELECTRIC TEST REACTOR — fuel pins of, physics measurements for plutonium oxide (PuO_2)-uranium oxide (UO_2)

HIGH-TEMPERATURE LATTICE TEST REACTOR — reactivity of graphite moderated thorium oxide (ThO_2)-uranium carbide (UC_2) and uranium carbide (UC_2)-vanadium oxide (V_2O_3) fueled

NEUTRONS — attenuation in Type 304 and Type 316 stainless steels, comparison of
NEUTRONS, FAST — spectra in Fast Neutron Cavity of PCTR, measurement of GCFBR and FTR lattices
PHYSICAL CONSTANTS TESTING REACTOR — reactivity of plutonium oxide (PuO_2)–uranium oxide (UO_2) fueled, effects of americium-241 buildup and plutonium-241 decay on
— reactivity worth of graphite moderated thorium oxide (ThO_2)–uranium oxide (UO_2) fuel blocks in
— neutron spectra in Fast Neutron Cavity of, measurement of GCFBR and FTR lattices
PLUTONIUM ISOTOPES Pu-241 — buildup in plutonium oxide (PuO_2)–uranium oxide (UO_2) lattice, effects on reactivity of
REACTOR FUEL ELEMENTS — reactivity worth of graphite moderated thorium oxide (ThO_2)–uranium oxide (UO_2)
REACTOR SAFETY EXPERIMENTS — physics measurements for EBR-2 and GETR fuel pins in TREAT
REACTORS — physics studies on, digital computer programs for
REACTORS, FAST — physics studies on, summary of January to March 1970
— accidents in, digital computer system for analysis of
REACTORS, THERMAL — physics studies on, summary of January to March 1970
STAINLESS STEEL — shielding properties of Type 304 and Type 316, comparison of (D.L.C.)

31042 (RPI-328-189) FORMULATION AND APPLICATION OF ANALYTIC REPRESENTATIONS OF FAST REACTOR FLUX AND IMPORTANCE SPECTRA. Dunn, Floyd E.; Becker, Martin (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Science). [1969]. Contract AT(30-1)-328. 79p. Dep. CFSTI.

A model is developed for the study of fast reactor flux and importance spectra. The model is based on slowing down theories of the continuous slowing down type with suitable modifications introduced where such theories are deficient. The ability to obtain analytic solution for the flux and importance spectra depends on the ability to fit basic cross section ratios (such as the moderating ratio) to simple analytic forms. The cross section fits are used to obtain an expression for the slowing down density, which generally is a smooth function. Detailed cross sections, however, are used to relate flux and importance to slowing down density. The model yields good agreement with multigroup spectra on both broad group and ultra-fine group bases and yields quite accurate values for integral parameters (e.g., criticality and reaction rates). In addition, it is found to be possible to get a good correlation of cross section fit parameters with composition. (10 references) (auth)

31043 (UJV-2352-R,T) NATURAL DISTRIBUTION OF THERMAL NEUTRONS IN THE ACTIVE ZONE OF FUEL ELEMENTS. Kujal, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Feb 1970. 26p. (In Czech). Dep. CFSTI (U. S. Sales Only).

The axial changes of thermal flux distribution as a function of burnup in heavy water lattices are analyzed. There is no axial dividing of the fuel element. The method of solving the differential equation in difference form is described. The results of one-group and two-group calculations are presented. (3 references) (auth)

31044 DELAYED FISSION NEUTRON DATA IN REACTOR PHYSICS AND DESIGN. Keepin, G. R. (Los Alamos Scientific Lab., N. Mex.). pp 3-22 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI/PUB-176; CONF-670424.

The basic input data required for all reactor physics and design calculations include: (1) fundamental nuclear cross-sections; (2) physical properties of materials; and (3) fission parameters, including yields and energy distributions of the delayed and prompt fission neutrons. Although prompt-neutron data are now reasonably well determined, more precise and more extensive data are becoming increasingly necessary in certain, expanding areas of nuclear technology. Some of the basic problems in fast reactor physics and design which require further knowledge of the yields and energy spectra of delayed neutrons are considered. The sensitivity of reactor physics parameters to variations in delayed- and prompt-neutron data are examined quantitatively, and specific areas in which further measurements are required and delineated. The role of delayed- and prompt-neutrons in detailed calculations of neutron importance and effective delayed-neutron fraction is developed and illustrated by specific examples. Such detailed studies are shown to be of particular importance in the field of fast reactor kinetics and control which is basic to the larger power breeder reactor development program now underway in the USA, USSR and Western Europe. (50 references) (auth)

31045 THE IMPORTANCE OF EXACT DELAYED NEUTRON DATA IN FAST REACTOR DYNAMIC BEHAVIOUR. Yiftah, S.; Saphier, D. (Technion-Israel Inst. of Tech., Haifa, Israel). pp 23-31 of Delayed Fission Neutrons. Vienna; International Atomic Energy Agency (1968).

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria. See STI/PUB-176; CONF-670424.

The way in which the uncertainties in delayed neutron spectra may affect the dynamic behavior of fast breeder reactors is discussed. It is shown that an exact knowledge of delayed spectra is a much more important requirement for fast than for thermal reactors. A few cases are given in which changes in delayed neutron effectiveness (γ_i), resulting from uncertainties in delayed spectra, may have serious consequences for the dynamic response and stability. Two simplified calculated examples illustrate this fact. The main cases in which delayed neutron effectiveness may be a crucial factor, and which require further investigation are: cases where local disturbances may cause serious flux tilting which may be affected by the local γ_i; cases of marginal stability in which changes in γ_i may shift the reactor into the unstable region (or into a more stable region); and cases where reactor regions are loaded with various fissionable isotopes having different yields of delayed neutrons and different spectra. In these cases it is difficult to predict the effect they may have on the reactor's dynamic performance. It is suggested that to approach solutions to the above problems, one has to solve the time-space and energy dependent Boltzmann equation for the reactor using appropriate approximations. An outline of a program for the evaluation of the importance of exact delayed neutron data in a fast reactors' dynamic behavior is given. (14 references) (auth)

31046 INVESTIGATIONS INTO THE DYNAMICS OF THE ADVANCED GAS-COOLED REACTOR (AGR). Carstairs, Ruthven; Joksimovic, Voin; Schatz, Alfred Karl (Atomic Power Construction, Ltd., Sutton, Eng.). At. Strom; 16: 58-62(Mar-Apr 1970). (In German).

The efficiency and the operational reliability of a reactor depend to a great extent on its dynamic behavior. The characteristics of the gas-cooled reactor and a program for the simulation of the transition behavior in normal operation and during breakdowns are described. By using calculations which were carried through with this program an explanation is given of the dynamic behavior of the AGR, particularly in the case of breakdowns. 6 references. (auth)

31047 SODIUM-COOLED REACTORS: EBR-II PHYSICS ASPECTS. Steele, Myrna L. (Division of Technical Information Extension, Oak Ridge, Tenn.). Reactor Technol.; 13: 170-85 (Spring 1970).

Core kinetic and neutronic parameters are presented on a per-run basis for Runs 25 to 35 of the EBR-II. This approach was chosen so that changes in core loadings could be correlated with measurements made under those very specific reactor conditions. Included are the results of reactivity-worth, power-coefficient, and transfer-function measurements; activation ratios, fission ratios, and capture ratios; neutron-flux measurements; and control-, shim-, and safety-rod calibrations. 24 references. (auth)

31048 RECENT DEVELOPMENTS IN FAST REACTOR KINETICS. Butler, D. K.; Meneley, D. A. (Argonne National Lab., Ill.). Nucl. Safety; 11: 289-95(Jul-Aug 1970).

Analysis of the safety of a fast breeder reactor requires calculation of the time-dependent neutron flux and fission-power densities. Methods for these calculations which are reviewed are those based on neutron-diffusion theory — point kinetic, adiabatic, quasi-static, and exact solutions. The methods are used in digital-computer programs in combination with those calculations of mechanical changes, fluid flow, and heat transfer which are required for the analysis of stability and accidents. Limitations of computer capability require the use of approximate methods where applicable. Comparison of results obtained with each method shows that the quasi-static or exact solution is required to obtain accurate values for power generation during severe transients. Incorporating these more accurate methods into computer programs which include equally accurate calculations of the thermal and mechanical effects will be important in developing computer codes for accident analysis. 34 references. (auth)

Control Systems

Refer also to abstract 29595.

31049 (BAW-10007) CONTROL ROD DRIVE SYSTEM TEST PROGRAM. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Jun 1969. 30p.

The testing program for a roller nut drive mechanism for pressurized-water reactor control elements is described. Test results for optimum alignment operation, misalignment operation, and stuck rod operation are presented. (D.C.C.)

31050 (ZJE-72) SINGLE-PURPOSE DIGITAL COMPUTER IN NUCLEAR ENGINEERING. Drab, F.; Lnenicka, B.; Kocandrle, L. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 9p. Dep. CFSTI (U. S. Sales Only).

The possibilities of using a digital computer in nuclear engineering are discussed, with special reference to the control of nuclear reactors. (auth)

31051 DESIGN AND EXPERIMENTS TO A QUICK SWITCH-OFF-SYSTEM WITH COLLECTION TANKS. Schuhmann, P. (AEG-Telefunken, Frankfurt am Main). Atompraxis; 16: 101-2; 105-8(Mar-Apr 1970). (In German).

The increasing of reactor power capabilities will cause an increase in the number of control rods required. Scram systems have increased in complexity, with the number of control rods. In the new scram system the number of all components of the system will remain constant and independent of number of control rods. (auth)

31052 AUTOMATIC BORON CONCENTRATION MONITORING IN PRESSURIZED WATER REACTORS. Steger, H. Kerntechnik; 12: 155-8(Apr 1970). (In German and English).

The technique of controlling the power output of pressurized water reactors by varying the concentration of boric acid in the primary circuit, the advantages of this technique, and the monitoring of boron concentrations at frequent intervals required for this purpose are described. The design and operation of an automatic titrator incorporating a minus-delta-p pump are described in some detail. 4 references. (auth)

31053 COMPUTING METHODS IN OPTIMIZATION PROBLEMS. Papers Presented at the 2nd International Conference, San Remo, Italy, September 9–13, 1968. Lecture Notes in Operations Research and Mathematical Economics, Volume 14. Berlin; Springer-Verlag (1969). 197p. $3.90. (CONF-680977).

Included are 19 papers on recent advances in computational methods for optimization problems in areas of control and trajectory, mathematical programming, economics, meteorology, bio medicine, identification, decoding and information retrieval, and pattern recognition. A separate abstract was prepared for each of 2 papers on nuclear reactor control. (H.D.R.)

For abstracts of individual papers see: 31054 and 31119.

31054 OPTIMAL CONTROL OF A NUCLEAR REACTOR POWER PLANT. Enns, Mark (Carnegie-Mellon Univ., Pittsburgh). pp 77-91 of Computing Methods in Optimization Problems. Berlin; Springer-Verlag (1969).

From 2nd International Congress on Computing Methods in Optimization Problems, San Remo, Italy. See CONF-680977.

A method is shown whereby a system may be used with a feedback control in a conventional closed-loop configuration, but still driven optimally by the addition of feed-forward signals. This gives the advantages of both a feedback control to take care of random disturbances, plant parameter variations, etc., and optimal control for large measurable disturbances. The methods are applied to a high-order model of a nuclear reactor power plant. The plant is first combined with a 4th-order feedback controller. Next, optimal trajectories are computed for the response to a load disturbance of the plant-controller combination. These control trajectories then form the basis of an optimal feedforward controller. The performance of the optimal system is compared with that under feedback control alone. It is shown that the optimal control gives better performance (tighter control over plant temperatures and pressure) with less control effort. (auth)

Shielding

31055 (ORNL-tr-2304) S_N APPROXIMATION OF THE TRANSPORT EQUATION FOR SHIELDING A NUCLEAR REACTOR. Burian, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Translated for Oak Ridge National Lab., Tenn., from report UJV-2125-R. 26p. Dep. CFSTI.

SUNSPHER and SUNCYL computer programs are described which calculate neutron fluxes in multilayer shields of nuclear reactors by Carlson S_n approximation. In spherical geometry the degree of expanding the flux is variable as well as the degree of anisotropic scattering. In cylindrical one dimensional geometry the anisotropic scattering in transport approximation is supposed and the degree of angular terms is variable. Input, output and an example of calculation are shown. The codes are in Algol language for the GIER computer. (6 references) (auth)

31056 TESTING OF A CHROMITE CONCRETE THERMAL SHIELD MODEL OF A REACTOR. Dubrovskii, V. B.; Mirenkov, A. F.; Zholdak, G. I.; Korenevskii, V. V. Sb. Tr., Mosk. Inzh.-Stroitel. Inst.; 56: 147-55(1968). (In Russian).

Many studies have been carried out in the Soviet Union on the use of heat-resistant cements for constructing reinforced-concrete thermal shields for reactors. Models have been found useful for testing the validity of theoretical calculations. Such a model was built, using a heat-resistant, chromite containing Portland cement with a specific weight of 3.0 tons/m^3. Ohmic heating was used for heating the cement to the desired temperature. Temperature gradients exceeding 10°C/cm could be established within the model by means of air cooling. It was found that the model could be subjected to temperatures of 300, 500 and 800°C for relatively long periods of time and to temperature cycling with a top temperature up to 800°C. The reinforcement was found to be more strongly deformed as the temperature differential is increased, reaching a maximum with a temperature gradient of 500 to 600°C. Formation of small cracks was also noted. It was concluded that study of models is a useful technique for determining temperature-generated gradients in thermal shields made of reinforced concrete. (TTT)

Cooling Systems

Refer also to abstract 29592.

31057 (APDA-251) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, OCTOBER–DECEMBER 1969. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 46p. Dep. CFSTI.

Tube wastage by sodium–water reactions in steam generators is analyzed. Test results for Cr–Mo–steel tubes and carburized Type 316 stainless steel capillaries are presented A comparison of methods for calculating and measuring heterogeneity effects in fast reactor critical assemblies and power reactors is presented. 12 references. (D.C.C.)

31058 (TRG-Report-1961) HOTSPOT: AN IBM 7090 COMPUTER PROGRAMME FOR CALCULATION OF SYSTEMATIC CAN AND FUEL TEMPERATURES IN GAS-COOLED ROD-CLUSTER FUEL CHANNELS. Cowking, C. B. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Feb 1970. 44p. Dep. CFSTI (U. S. Sales Only). UK 5s. 6d.

The HOTSPOT computer program performs detailed channel heat-transfer calculations for gas-cooled rod-cluster fuel elements formed on concentric rings of fuel rods allowing for many of the factors which give rise to systematic can and fuel temperature variations. Non-uniform radial distribution of coolant flow and the variations in rating radially between and within rings of fuel rods and axially within assemblies and along the channel, are considered. The amelio-rating influences of heat and mass flow between the parallel coolant passages are also included in the calculation. Circumferential symmetry is assumed. The method is aligned with the results of twice-full-scale out-of-pile experiments in air and carbon dioxide carried out at R. D. L. Windscale. In future it will be of use in the analysis of in-pile temperature measurements and to designers in their selection of the cluster geometries most appropriate to the expected distribution of heat generation. The equations forming the bases of the program, the computer input details and all the data involved in a specimen calculation are given. (auth)

31059 CONTROL OF BOILING-WATER REACTORS IN DIFFERENT SYSTEM CIRCUITS. Reinhardt, Alfred (AEG-Telefunken, Frankfurt am Main). At. Strom; 16: 53-7(Mar-Apr 1970). (In German).

According to the system circuit, different designs are used for the control of boiling-water reactors. On the basis of the physical relationships these are explained and their advantages in each case emphasized. 7 references. (auth)

31060 GENERAL METHOD FOR STUDYING THE CORROSION PRODUCTS BUILD-UP IN THE PRIMARY CIRCUIT OF A REACTOR. Bonalumi, R. (CISE, Milan); Olivi, A. Energ. Nucl. (Milan); 17: 302-11(May 1970).

The basic mechanisms which control the build-up of corrosion products in the primary circuit of a reactor are discussed. A set of coupled differential equations describing the time-dependent, point-wise distribution of both active and inactive corrosion product nuclides in the coolant and on the circuit walls are formulated. A Lagrangian viewpoint integration over the circuit and adoption of a few mathematical approximations leads to explicit solution of the equations. The entirely theoretical work is mainly aimed at stating the dependence of the nuclear concentrations of interest on some typically material constants to be obtained by best-fitting experimental curves. (auth)

31061 RECENT ADVANCES IN THE TECHNOLOGY OF PRESTRESSED-CONCRETE REACTOR PRESSURE VESSELS. Tan, Chen Pang (Franklin Inst. Research Labs., Philadelphia). Reactor Technol.: 13: 109-21(Spring 1970).

Papers on significant advances in techniques and concepts for the utilization of prestressed-concrete pressure vessels (PCRV's) in nuclear reactors are summarized. The papers were presented at the Second Conference on PCRV's and Their Thermal Insulation, held November 1969, in Brussels. PCRV technology is discussed in sections on (1) research and development, (2) practical experience, (3) properties of materials, (4) new types of vessel design and model testing, (5) methods of analysis, and (6) thermal insulation. 37 references. (H.D.R.)

31062 DIMENSIONING OF PRESSURIZERS. Santarossa, Giampiero. Ing. Nucl.; 10: No. 4, 38-47(Jul-Aug 1969). (In Italian).

The characteristic operational conditions of pressurizers are examined, and a method for the calculation of the pressure is presented. The method is analyzed from the hypothesis justifying the opportunity of the adoption of the most simple calculation form. Some dimensioning criteria are deduced from the method proposed. 6 references. (tr-auth)

31063 METHOD AND RESULTS OF THE THERMODYNAMIC ANALYSIS OF THE DUTY CYCLE OF ELECTRONUCLEAR POWER PLANTS EQUIPPED WITH GAS-COOLED REACTORS. Haiduc, C.; Vidican, P. Stud. Cercet. Energ. Electroteh.; 19: No. 1, 77-97(1969).

The effects of the complexity of the thermodynamic cycle and steam generator thermal schemes on the thermal efficiency are discussed. (Fuel Abstr.)

31064 TRANSIENT BEHAVIORS IN A NUCLEAR POWER PLANT. STUDY OF THE PRIMARY CIRCUIT. Le Glas, J. M.; Micheau, P.; Martin, B. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 78, 11-18(Jul-Aug 1969). (In French).

A mathematical model of an integrated gas reactor was created. This model makes it possible to determine during transitory regimes at low power levels the time evolution of pressure, temperature, primary fluid (gas) flow, and temperatures of materials placed in the reactor. The reactor was decomposed into block elements, each element being in relation with only two contiguous elements. For the core element, a multi-channel model was chosen. The establishment of equations tracing the evolution of the primary fluid was made, beginning with certain hypotheses, the essential one being that of a locally monodimensional flow. The resolution of the equations was made by a discretization method programmed on a numerical computer. The basic choice of a multi-channel core model made it possible to show in some cases the establishment in the core of an "internal thermosiphon" although the total output in the reactor is zero. The cladding temperatures calculated are very different from those obtained with a unichannel model. These temperatures vary only slightly when the number of sample channels is higher than 2. The calculation program created resolves, for the initial conditions and at the limits given, the three equations of the mechanics of fluids (equations of continuity, of quantity of movement, and of energy) coupled with the heat equation. It results that the methods developed are very general and can be applied to the study of any circuit composed of sections placed in parallel or in series, providing each can be assimilated to a monodimensional flow. (tr-auth)

Fuels

Refer also to abstracts 30017 and 30019.

31065 (CONF-700502–, pp 31-48) HTGR FUEL DESIGN. Turner, R. F.; Goeddel, W. V.; Winkler, E. O. (Gulf General Atomic, Inc., San Diego, Calif.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

The hexagonal block fuel element was established as the design concept for large HTGR power plants in the United States. Summary descriptions of this fuel element and typical reactor core assemblies are presented. The element contains spherical fuel particles, which are very amenable to fabrication by the sol-gel process. Extensive irradiation test data to high burnups and to high fast fluences confirm the good integrity of reference fuel materials for the HTGR. The Th–^{233}U fuel cycle appears most favorable economically for the HTGR. Fuel particles are fabricated in such a way that recycled ^{233}U can be kept segregated from make-up ^{235}U in order to avoid the buildup of parasitic ^{236}U. (auth)

31066 (CONF-700502–, pp 49-58) LMFBR FUEL ELEMENT DESIGN. Bernath, L.; Sayles, C. W.; Abraham, L. (Atomics International, Canoga Park, Calif.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Typical reactor system requirements that are imposed on the design of the LMFBR fuel elements are presented. The analytical techniques, used to assure that those requirements are satisfactorily met, are described; and a summary of the characteristics of such a design is presented. Research and development activities and progress are reviewed to highlight the efforts of the AI/GPU Demonstration Plant Program to achieve the stated goals and performance characteristics. (auth)

31067 (CONF-700502–, pp 534-50) LIGHT WATER REACTOR FUEL ELEMENT DESIGN. Meieran, H. B. (Nuclear Materials and Equipment Corp., Apollo, Pa.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Fuel rods for Light Water Reactors (LWR) must today be a product that can be irradiated during a service period with a minimum chance of failure. The fuel elements are being irradiated to high burnup and power levels and contain a large inventory of fission products. The discharge of a large amount of these fission products into the coolant of a LWR will impose technical and economic hardships upon the operating utility company with respect to their capabilities of performing maintenance work. The LWR fuel rod design must also include consideration of the three primary causes of fuel failures: corrosion, fabrication defects, and irradiation performance. The critical material performance parameters of fuel swelling, fission gas release, pore/fission gas migration, creep of the cladding, mechanical deterioration of the cladding properties from hydrogen pickup, and axial expansion of the fuel stack which can contribute to in-service failures can be accommodated with appropriate design procedures. Thus with access to operating experience, experimental data, and analytical techniques, fuel rod failures can be predicted, and mechanical integrity of the fuel rod can be ensured. (auth)

31068 (LA–4411) OBSERVATIONS OF UHTREX FUEL ELEMENTS DURING REACTOR STARTUP OPERATIONS. Weintraub, Larry (Los Alamos Scientific Lab., N. Mex.). Dec 1969. Contract W-7405-eng-36. 14p. Dep. CFSTI.

Studies of the fuel element performance during initial UHTREX reactor operations were undertaken to assess the degree of attrition and other effects on fuel element materials. Observations included pre- and postexposure weighing, precise measurements of the fuel element dimensions, and photography. In addition, radiographic and metallographic examinations of sections of one element were conducted. The onset of corrosion effects was found to occur after exposure to reactor environments associated with operations above coolant outlet temperatures of 1900°F. Only minimal indications of fuel migration through the coated fuel particles were observed. The metallographic examination showed no evidence of particle or matrix damage. (auth)

31069 (RD/B/N–1550) ENVIRONMENTAL INFLUENCES ON FUEL BURNUP IN MK. III GCR'S: PART I. EQUILIBRIUM SITUATION (CONTINUED). PART II. EFFECTS OF CONTROL RODS. Ainger, P. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb 1970. 47p. (M–3-RPC/P-101). Dep. CFSTI (U. S. Sales Only).

The properties of fuel in two particular reactor situations are studied. An equilibrium HTR core is simulated by a non-leaking supercell. Comparisons are made between these results and the zero-leakage edit of the corresponding WIMS output. Environmental effects, in the form of 9-group bucklings as a function of irradiation, are derived from the supercells and used to constrain a further WIMS burnup. It is found that the changes in characteristics between these two runs are significant at any point in time, but small when averaged over life. The recycled data are then put into the supercells and the change observed is insignificant. Fuel close to a "grey" control rod is also investigated. A cylindrical supercell model is used and gives a hardened spectrum near the rod, which is reflected in a considerable change of properties of the fuel. It appears that a 2-group calculation is incapable of representing this situation adequately. Bucklings for the rodded block are then put into WIMS and an appreciable change in fuel properties is observed. It is also found that rod-worth varies considerably with the irradiation of adjacent fuel, and that the error in using unrecycled data to predict this is significant. It is estimated that a simple 2-group recycle should be adequate for many purposes. 5 references. (auth)

31070 INFLUENCE OF FISSION GAS PRESSURE ON THE DESIGN OF FUEL ELEMENTS WITH METALLIC CLADDING FOR NUCLEAR REACTORS. Eisner, J. H. Atompraxis; 16: 96; 99-100(Mar-Apr 1970). (In German).

The criteria due to fission gas release for fuel element cladding of advanced reactor concepts are given. Cylindrical as well as spherical fuel elements are investigated. For cylinder geometry

also the influence of prepressurizing is taken into consideration. As a result it can be stated that when metallic fuel element cladding is used the sphere is not a suitable geometry for fuel elements of nuclear reactors with high power density and burnup. (auth)

31071 FEATURE ESTABLISHMENT OF FUEL CYCLE IN JAPAN. I. TECHNICAL AND ECONOMICAL STUDY. FUEL CYCLE AND FUEL FABRICATION FOR PWR. Seki, Yoshitatsu (Mitsubishi Atomic Power Industries, Inc., Tokyo). Genshiryoku Kogyo; 16: No. 1, 19-22(Jan 1970). (In Japanese).

Atomic power stations are being built in Japan and the power plants employing PWR are also emerging, e.g. those in the Mihama Atomic Power Station. In this situation, the production of nuclear fuel is one of the important points in the overall fuel cycle. Mitsubishi Atomic Power Industry and Mitsubishi Metal Mining Co. are now building plants for the purpose. The production of nuclear fuel for PWRs is described in the following: (1) Fuel production in the overall fuel cycle. The program of fuel production must be carried out, taking into account the overall nuclear fuel cycle. (2) Fuel production for PWRs. The plant by MAPI, producing fuel pellets, rods and assemblies, a conversion plant, and also Zircaloy clad tubes, UO_2 scrap refining, etc. are described. (3) Fuel production techniques and quality control. Actually, the production technique is standardized on the basis of quality control. The manufacture of fuel rods and pellets with rigorous requirement, the delivery, and so on, are described. (NSA of Japan)

31072 FEATURE ESTABLISHMENT OF FUEL CYCLE IN JAPAN. TECHNICAL AND ECONOMICAL STUDY. FUEL CYCLE AND URANIUM RESOURCES. Koyama, Takeo (Science and Tech. Agency, Tokyo). Genshiryoku Kogyo; 16: No. 1, 8-11(Jan 1970). (In Japanese).

In the overall energy policy in Japan, it is important to secure the supply of nuclear fuel. Japan must depend mostly on import for the fuel. In the world, many countries are endeavoring to develop nuclear fuel resources, for instance in Canada, Africa, etc. It is time for Japan to do the same, not to repeat the case of petroleum. With a view to this situation, the following are described: the need for Japan to develop U resources overseas; the amount of U reserves and long-range demand; supply and demand, and the trend of price; U resource development by oversea countries; the measures to be taken hereafter in Japan; and the expenditure necessary for Japan to develop oversea U resources. (NSA of Japan)

31073 FEATURE ESTABLISHMENT OF FUEL CYCLE IN JAPAN. II. TECHNICAL AND ECONOMICAL STUDY. FUEL CYCLE AND REPROCESSING. Miyoshi, Masahiko (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 16: No. 1, 29-32(Jan 1970). (In Japanese).

In Japan, electric power companies are building atomic power stations one after another, and the era of the practical use of atomic power generation is coming. At this rate, the power generation by atomic energy in Japan will be 50,000,000 kW or more in 1985. The cumulative amount of plutonium in 1985 from light-water reactors will then reach 50 T. Considering the price of $10 per gram of Pu, the fuel reprocessing is invaluable. Nuclear fuel reprocessing is described in association with the nation's fuel cycle. The use of Pu, the utilization of depleted U, the need of fuel reprocessing for Japan, the reprocessing program in Japan and prospective reprocessing plant, and the present state and trend in this field in oversea countries are discussed. (NSA of Japan)

31074 RESEARCH AND DEVELOPMENT OF FUEL FOR LIQUID METAL FAST BREEDER REACTOR. Muto, Tadashi; Komatsu, Junji; Naruki, Kaoru (Power Reactor and Nuclear Fuel Development Corp., Tokai, Japan). Genshiryoku Kogyo; 16: No. 2, 77-82(Feb 1970). (In Japanese).

Apart from pellet-type fuel, the vibration-packing method of producing nuclear fuel is important because of its easy remote operation and low cost. The mixed-oxide fuel, produced by this method, is highly promising, compared with low-density pellet fuel, as the former has small swelling. The recent development in the production of packing powder and the packing techniques is reviewed. The sol-gel method, based on the gel resulting from sol by colloid chemistry, has the advantages of high economy, good adaptability to fuel reprocessing, etc. The case of producing (Pu, U) O_2 fuel is described. The dyna-pack method utilizes impulsive shock-energy to prepare powder, and either direct or indirect technique is adopted. There are two kinds of packing method: Vibration packing and Sphere-Pac method. The difference between the two is that particle size is uneven in the vibration packing, while it is uniform in the Sphere-Pac. The Sphere-Pac method has the advantage of easy preparation of powder. (NSA of Japan)

31075 FEATURE ESTABLISHMENT OF FUEL CYCLE IN JAPAN. III. TECHNICAL AND ECONOMICAL STUDY. FUEL CYCLE AND PLUTONIUM. Nakamura, Yasuharu (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 16: No. 1, 33-7(Jan 1970). (In Japanese).

The position of Pu in a fuel cycle, and its contribution to the cost of atomic power generation are described. Further, in the long-range program of atomic power generation involving ATR and FBR, the situation of Pu is examined. Safety in criticality, health, and in the production of Pu fuel, and the cost of producing the fuel are explained. Pu consists of various isotopes, each differing from the other in nuclear characteristic. The different arrangement of Pu fuel in a reactor core, and the respective behavior, are explained, taking the Thermal Criticality Assembly in JAERI as one instance. The research and development of Pu fuel production in Japan mainly by Power Reactor and Nuclear Fuel Development Corporation is described. (NSA of Japan)

31076 RESEARCH AND DEVELOPMENT OF FUEL FOR LIQUID METAL FAST BREEDER REACTOR. Kikuchi, Takeo (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 16: No. 1, 85-9(Jan 1970). (In Japanese).

The irradiation behavior of nitride fuel is discussed in comparison with that of carbide fuel. Though there have been many instances that the swelling of fuel in high burnup was measured, the quantitative relation between swelling and the fabrication method of fuel, initial density, irradiation temperature and other factors has not been made clear. Generally, the volume increase of UN shows a remarkable upturn when the temperature in the center of the fuel is above 1000°C. According to the data of $(U_{0.8}\ Pu_{0.2})N$, it seems that volume increase runs in parallel with burnup. Though fission gas release rate seems to increase with temperature rise, the relation between this tendency and the fabrication method and density of the sample has not been clarified. The swelling of fuel by irradiation is mainly attributed to the volume increase caused by the growth of fission gas bubbles and by the solid dissolution or precipitation of solid fission product into crystal lattices. The change of the lattice constant of UN by irradiation, the relation between porosity and temperature in the irradiated UN, the self-diffusion coefficient of atom N and U in UN, and the diffusion of ^{133}Xe in UN were investigated. On the whole, nitride fuel has no especially great fault in comparison with carbide fuel. (NSA of Japan)

Auxiliary and Emergency Systems

Refer also to abstract 29998.

31077 DEVELOPMENT OF A SPHERICAL PRESSURE SUPPRESSION SYSTEM. Zeitzschel, G. (AEG-Telefunken, Frankfurt am Main). Kerntechnik; 12: 149-54(Apr 1970). (In German and English).

The development of a safety vessel combining pressure- and gas-tightness with the advantage of great compactness is described. The concept, the engineering design, and the structural features of this new type of safety vessel are described. In conclusion, this new design is compared to the two most common types of safety containment used up to now. (auth)

Operation and Economics

31078 (CONF-700502–, pp 2-11) HTGR FUEL CYCLES AND ECONOMICS. Dahlberg, R. C.; Colby, L. J. Jr. (Gulf General Atomic, Inc., San Diego, Calif.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

The uranium-thorium cycle is the reference fuel cycle for HTGRs. ^{233}U recycle reduces yearly requirements for 93% enriched uranium by about 30% for an 1100 MW(e) plant. ^{233}U recycle also results in fuel cycle costs about 0.2 m/kwh less than the throwaway cycle. When plutonium from LWRs or FBRs is used as the makeup fissile material for HTGRs, the indifference value is $9.80 per gram fissile Pu. The coated particle type fuel permits the adverse effect of ^{240}Pu to be controlled through self-shielding. The penalty associated with ^{236}U can also be minimized through the use of particle type fuels and the self-shielding that results. The development of the necessary fuel recycle technology for HTGRs, although aimed specifically at the reference thorium-uranium cycle, will be applicable to the efficient utilization of plutonium in HTGRs. (auth)

31079 (CONF-700502–, pp 12-29) FAST REACTOR FUEL CYCLE ECONOMICS. McVey, William H.; Haberman, Norton; Sege, Carol A. (Atomic Energy Commission, Washington, D. C.).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Information is presented relating the fuel cycle costs for the

Liquid Metal Fast Breeder Reactor to core burnup, ex-reactor operations, fissile plutonium value, and interest rates. (auth)

31080 (CONF-700502–, pp 522-33) LIGHT-WATER-REACTOR FUEL-CYCLE COSTS: A MOVING TARGET. Guthrie, C. E.; Geller, L. (Stoller (S. M.) Associates, New York).

From Symposium on Sol-Gel Processes and Fuel Cycles.

Continual reductions in light-water-reactor fuel-cycle costs can be expected over the next decade due to improvements in reactor and fuel design, improved fuel cycle processes, and the economics of increased scale of operation. First core fuel cycle costs of reactors starting commercial operation in 1970 are in the order of 2.26 mills/kWh. This should decrease to around 1.55 mills/kWh for reactors starting operation in 1980. (auth)

31081 (HPR–124) HBWR QUARTERLY PROGRESS REPORT, JANUARY–MARCH 1970. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). May 1970. 98p. Dep. CFSTI (U. S. Sales Only).

HALDEN BOILING REACTOR—operations during January to March 1970
—control system for, development of digital computer
—fuel elements for, burnup and post-irradiation examination of test
REACTOR CONTROL SYSTEMS—development of digital computer
REACTOR FUEL ELEMENTS—radiation testing of Zircaloy clad uranium oxide (UO_2) pin type (D.C.C.)

31082 OPTIMIZATION OF SYSTEMS BY RELIABILITY- AND AVAILABILITY-ANALYSIS. Daublebsky, P. (AEG-Telefunken, Frankfurt am Main). Atompraxis; 16: 77-82(Mar-Apr 1970). (In German).

After an introduction in the theory of reliability analysis the new methods are explained for the calculation of repairable redundant systems. The principal considerations on the optimum of the test interval and availability are given. As an example of the application of this theory the scram system of the nuclear power plant Würgassen is optimized. (6 references) (auth)

31083 ECONOMIC STRATEGY FOR DEVELOPING NUCLEAR BREEDER REACTORS. MacAvoy, Paul W. Cambridge, Mass.; Massachusetts Institute of Technology Press (1969). 213p. $12.50.

The breeder reactor development program in the U. S. is reviewed. Forecasts of the costs of fast breeder programs are presented, and a model of the energy sector of the American economy is constructed to evaluate benefits. Emphasis is placed on an examination of alternative breeder programs offering greater or less benefits. The research project mix offering the largest present value of forecast economic benefits over and above research costs is evaluated. The program which meets this standard requires duplicate research in separate companies, both to increase the number of breeder types and to increase the benefits from reduced industry concentration. (H.D.R.)

31084 SODIUM-COOLED REACTORS: CURRENT STATUS. Steele, Myrna L. (Division of Technical Information Extension, Oak Ridge, Tenn.). Reactor Technol.; 13: 186-90(Spring 1970).

Plant-systems operating experience is summarized for the EBR-II (July–December 1969) and for the Fermi Fast Breeder Reactor (May–September 1969). The summary updates two previous reviews. 13 references. (auth)

31085 OPTIMUM BURN-UP MANAGEMENT AND ITS METHOD FOR FUEL IN A REACTOR. Hamada, H. (Tokyo Electric Power Co. Inc.). Genshiryoku Kogyo; 16: No. 2, 49-52 (Feb 1970). (In Japanese).

Optimum fuel cycle management in reactors concerns safety of operation, maximum fuel burnup, the timing and quantity of fuel exchange, and fuel administration. Advantages and disadvantages of fuel cycle control by the utility, the reactor manufacturer, or the fuel fabricator are discussed. The method used for calculation of fuel cycle optimization in boiling water reactors is described, and the variables considered in actual application of the method are examined. (NSA of Japan)

Safety and Siting

31086 (ORNL-tr-2333) FORMATION AND REMOVAL OF RADIOACTIVE ORGANIC IODIDE. Kitani, Susumu. Translated by A. Fukuda (Oak Ridge National Lab., Tenn.), from Genshiryoku Kogyo; 14: No. 5, 48-51(1968). 15p. Dep. CFSTI.

Data are tabulated on gases released from unirradiated UO_2 heated to high temperature. Possible mechanisms of methyl iodide formation from methane and iodine released from irradiated UO_2 are examined. The effectiveness of activated charcoal filters and chemical additives for removal of methyl iodide is described, and the effects of temperature, humidity, flow rate, etc., on methyl iodide removal are discussed. 19 references. (H.D.R.)

31087 NUCLEAR SAFETY. VOLUME 11, NUMBER 4. Cottrell, Wm. B.; Blakely, J. P.; Jordan, W. H.; Savolainen, A. W. (eds.). One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn.; Oak Ridge National Laboratory (July–Aug 1970). 84p. GPO $0.60.

Topics reviewed include: general safety considerations; accident analysis; control and instrumentation; plant safety features; operating experiences; and current events. Separate abstracts are included for 9 of the 10 articles presented. One article not abstracted discussed reliability problems with reactor mechanical components and systems. (D.C.C.)

For abstracts of individual papers see: 31033–31035, 31048, 31088–31090, 31110, and 31130.

31088 SAFETY ASSESSMENT OF FAST SODIUM-COOLED REACTORS IN THE UNITED KINGDOM. Farmer, F. R. Nucl. Safety; 11: 283-8(Jul-Aug 1970).

The building of any reactor introduces some risk to the public, but it appears that the fast reactor may present less risk than current reactors because it can be designed so as not to require a power source when shut down. Since it is unlikely that it can ever be positively established that every energy release can always be contained, reliance must be placed in the greater likelihood of identifying the fault and shutting down the reactor. The objective of current safety research is to provide two independent mechanical shutdown systems activated by independent signals. Means are being developed for detection of fuel-subassembly failures through delayed neutrons, fission products, acoustics, and possibly the shock of subassembly collapse. 2 references. (auth)

31089 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Savolainen, A. W.; Whetsel, H. B. Nucl. Safety; 11: 330-42(Jul-Aug 1970).

Topics discussed include: HSST programs for water cooled reactors; environmental and effluent control studies for power reactors; general safety studies; fast reactor safety; and gas-cooled reactor safety. (D.C.C.)

31090 GENERAL ADMINISTRATIVE ACTIVITIES. Blakely, J. P. Nucl. Safety; 11: 342-6(Jul-Aug 1970).

Power Conversion Systems

31091 DYNAMIC INVESTIGATION OF A SODIUM STEAM GENERATOR. Schomer, Eberhard (Siemens AG, Erlangen, Ger.). At. Strom; 16: 62-70(Mar-Apr 1970). (In German).

The investigation on the analog computer which is described concerns the non-steady-state behavior in the case of a breakdown on the steam generator reheater system in the Na-cooled fast breeder reactor project (SNR 300). After a short description of the circuit for the heat circulation systems for the SNR 300, the data are used for a calculation model. Further, the dynamic preliminary investigation of the reheater by means of a digital analog simulation, and the combination into an overall model, are discussed. The results are explained by using diagrams. 10 references. (auth)

Research and Test Reactors

Refer also to abstracts 29468, 29919, 29995, 30049, 30667, 31035, and 31041.

31092 (AE–392) MEASUREMENT OF THE NEUTRON SPECTRA IN FRO CORES 5, 9, AND PuB-5 USING RESONANCE SANDWICH DETECTORS. Andersson, T. L.; Qazi, M. N. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Apr 1970. 30p. Dep. CFSTI (U. S. Sales Only).

A common way to get some information about a neutron spectrum in the energy range 1 eV to 3 keV is the use of resonance sandwich detectors. Four different sandwich materials were used for studies of the low energy part of the spectrum in the center of the FR0 cores 5 and PuB-5, utilizing the reactions $^{197}Au(n,\gamma)$, $^{186}W(n,\gamma)$, $^{55}Mn(n,\gamma)$, and $^{23}Na(n,\gamma)$ with the main resonance energy 4.9 eV, 18.8 eV, 337 eV and 2850 eV, respectively. Measurements were also made in the FR0 core 9. Here, however, the gold and tungsten sandwiches could not be used due to the low neutron flux at the main resonance energies in question. An experimental method was used in core 5 to make the necessary corrections for

the influence of secondary resonances. The sandwiches were irradiated in a separate run under boron-10 filters, the transmission properties of which had been determined in a special measurement. The correction in question was also determined by calculations based on resonance integral data for each resonance and a calculated spectrum for the FR0 core under consideration. The measurements have been compared with calculated spectra. It is shown that the DORIX–SPENG programme calculates the comparatively hard core 9 spectrum quite well, but mispredicts the low energy part (below about 100 eV) of the softer core 5 and PuB-5 spectra. A core 5 spectrum produced by the UKAEA programmes SDR and WDSN gives good agreement with the experimental points (except at 4.9 eV) indicating that the resonance region below about 100 eV is not properly handled by the DORIX–SPENG programme. For core PuB-5 the agreement between calculated and measured spectra is poor even at the high energy end of the interval under consideration. This disagreement may be explained by the rather strong heterogeneity effect in this core. 17 references. (auth)

31093 (ANL-EBR-9) BURNUP: A CODE TO CALCULATE BURNUP OF EBR-II FUEL. EBR-II Project. Masters, S. M.; Engen, I. A.; Kirn, F. S. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Feb 1970. Contract W-31-109-eng-38. 38p. Dep. CFSTI.

The EBR-II BURNUP code was developed to provide a record of subassembly disposition and to calculate fuel burnup and irradiation time to a certain burnup limit for each subassembly in the reactor during a given run. A historical record is kept of each partially irradiated subassembly that has not yet been transferred from the reactor storage basket. The nuclear center of the reactor is found from the calibrated worths of the control rods for each run. The purposes, functions, and input and output for the code are presented. 3 references. (auth)

31094 (BNWL-1200-3) SODIUM TECHNOLOGY QUARTERLY REPORT, JANUARY–MARCH 1970. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr 1970. Contract AT(45-1)-1830. 116p. Dep. CFSTI.

Programs related to the control of coolant quality for the FFTF are described. Topics discussed include: Na system chemistry; Na coolant studies; Na analysis; Na system engineering; and oxygen-sensing solid electrolytes. (D.C.C.)

31095 (BNWL-1339) ACTIVATION AND SHIELDING OF FTR SODIUM. Mansius, C. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr 1970. Contract AT(45-1)-1830. 32p. Dep. CFSTI.

The Fast Test Reactor (FTR) primary coolant is calculated to contain 1.2×10^7 Ci of ^{24}Na and about 10^2 Ci of ^{22}Na under equilibrium conditions at 400 MW. Each closed loop will contain about 3×10^4 Ci of ^{24}Na and almost 1 Ci of ^{22}Na. These values are based on two-dimensional, 31-neutron group diffusion theory calculations employing conceptual design dimensions and compositions for the arrangement within the reactor vessel. Shielding calculations are presented for piping, pumps, and heat exchangers containing activated sodium that provide a basis for shield design of pipeways and heat transport cells. 6 references. (auth)

31096 (BNWL-1383) POWER TESTS WITH THE UO_2–2 WT. PERCENT PuO_2 BATCH CORE IN THE PRTR. Kutcher, J. W.; Smith, R. I. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. Contract AT(45-1)-1830. 53p. Dep. CFSTI.

As a part of the BATCH CORE EXPERIMENT in the Plutonium Recycle Test Reactor (PRTR), a series of power tests was conducted when the reactor loading was completed, at various powers up to 60 MW. These tests were designed primarily to verify predicted operational characteristics of the PRTR with the BATCH CORE loading, but also included those physics tests which required power operation. The tests included flux traverses, operation of the traveling flux wire system, transient response of the reactor to the addition and removal of boron from the D_2O moderator, determination of reactor power, temperature coefficients of reactivity, kinetics parameters, and the growth and decay of fission product poisoning. Results of these tests are presented. 11 references. (auth)

31097 (CEA-N-1233) SQUARE ROOT COMPUTER. Da Costa Vieira, David; Bertrand, Jean; Tattegrain, Alain (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Feb 1970. 10p. (In French). Dep. CFSTI (U. S. Sales Only).

The square root computer is used for a special measurement on a loop of nuclear reactor Cabri. It provides a 0 to 10 volts continuous voltage signal which is proportional to the square root of the 0 to 10 volts input continuous signal. The basic principle pertains to operations on logarithms. (auth) (France)

31098 (CEA-N-1263) AIR FLOW CONTROL DEVICE IN THE RAPSODIE REACTOR TERMINAL EXCHANGERS. Bouras, Florent; Rion, Jacky (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Feb 1970. 15p. (In French). Dep. CFSTI (U. S. Sales Only).

This device controls the position of the electro-pneumatic regulator of the Rapsodie reactor terminal sodium-air heat exchangers, taking into account the input temperature of the cooling air. The required reliability and maintainance led to a very simple design. (auth) (France)

31099 (DOCKET-50231-46) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. License No. DR-15; Technical Specifications Change No. 1. (Division of Reactor Licensing (AEC), Washington, D. C.). 5 Jun 1970. 6p. Dep. CFSTI.

Information related to the safety aspects of mounting thermocouples in the nickel reflector segments or in the aluminum guide structure is presented. (D.C.C.)

31100 (FMRB-30/69) BRAUNSCHWEIG RESEARCH AND MEASUREMENT REACTOR. Operations Report, November 1968–December 1969. Heintz, W.; Siegel, V. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Dec 1969. 60p. (In German). Dep. CFSTI (U. S. Sales Only).

The operating experience and radiation protection activities with the Forschungsund Messreaktor, Braunschweig, in the year 1969 are described. After raising the primary coolant flow and installation of the heavy water tank, the reactor could be operated with two coupled cores at 1 MW. (auth)

31101 (JUL-629-RW) REQUIREMENTS FOR GAS COOLANT FOR AN IRRADIATION CIRCUIT ESPECIALLY FOR THE CO_2 LOOP LV 5 AND THE He LOOP LV 17. Krug, Wolfgang (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Dec 1969. 9p. (In German). Dep. CFSTI (U. S. Sales Only).

Cooling gas for the CO_2 loop and helium loop were studied. Commercial gas contained impurities in the form of oxygen, nitrogen, argon, hydrogen, water, and carbon compounds. Of these, only ^{40}Ar presented a problem because the others have too small a neutron capture cross section to produce any radioactivity. For testing, helium was pumped through a trap containing silica gel and activated charcoal. After a certain time, the trap was heated and the impurities determined by gas chromatography. For CO_2 testing, the gas flowed through potassium hydroxide. All of the CO_2 was precipitated while the impurities escaped and were analyzed by gas chromatography. Argon content in CO_2 should not exceed one part per million to keep the dose rate at 2.5 mrem/hour. Because of its smaller size, the helium loop tolerated argon impurities four times higher than the CO_2 loop. (H.B.G.)

31102 (JUL-630-RW) PRELIMINARY THERMODYNAMIC TESTS OF THE He-COOLED FUEL ELEMENT LOOP LV 17 WITH NATURAL ROTATIONAL COOLING. Krug, Wolfgang (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Dec 1969. 26p. (In German). Dep. CFSTI (U. S. Sales Only).

Rods, composed of spheres and heated electrically, were used as models for fast breeder fuel elements. These rods were inserted into the loop LV 17 of a Juelich reactor. The loop was cooled by high-pressure helium circulation. The models, heated up to 1200°C, showed that reactor cooling and reactor temperature had a negligible influence on the loop temperature. The dominant factors were rod heating and helium flow. Consequently, reactor cooling systems needed no modification to accommodate the helium loop. It was demonstrated that, even in cases of sudden reactor shutdowns, the loop could operate safely. (H.B.G.)

31103 (N-70-19195) NEUTRON AND GAMMA MEASUREMENTS FOR THE NASA PLUM BROOK REACTOR HB-6 BEAM HOLE INSERTION FACILITY. Weinstein, Suzanne T.; Kish, James A. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb 1970. 19p. (NASA-TM-X-1962; E-5358). CFSTI.

The fast and thermal neutron fluxes in the NASA Plum Brook Reactor HB-6 beam hole were measured using standard neutron activation techniques. The γ ray exposure rate in the beam hole was measured with Ar-filled ion chambers. The measurements were made as a function of position along the HB-6 beam. The effects of position across the beam face and of reactor shim rod bank height were also determined. (auth) (STAR)

31104 (SRARI-P-56) AN AMPOULE CHANNEL FOR THE IRRADIATION OF CONSTRUCTION MATERIALS IN AN SM-2 REACTOR WITH TEMPERATURE ADJUSTMENT BY VARYING THE SIZE OF THE GAS GAP. Lobanov, G. P.; Samsonov, B. V.; Timchenko, R. A.; Tsykanov, V. A.; Shulimov, V. N. (Scientific Re-

search Atomic Reactor Inst., Melekess (USSR)). 1969. 22p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The construction description and principal capsule channel characteristics destined for the construction materials irradiation under an elevated temperature (>500°C) in SM-2 reactor are given. The channel construction permits a temperature adjustment of specimens during irradiation by varying the thermal resistance value (the helium gap thickness) between specimens in which heat is generated, and by the reactor coolant removing this heat from the capsule channel body. (auth)

31105 NEUTRON WAVE EXPERIMENTS IN A HEAVY WATER-NATURAL URANIUM SUBCRITICAL ASSEMBLY. Wagner, R. (Institut fuer Neutronenphysik und Reaktortechnik, Karlsruhe, Ger.). J. Nucl. Energ; 24: 71-84(Apr 1970).

Experiments were made to measure the propagation properties of thermal neutron waves in D_2O-natural uranium systems. Experimental results are compared with former die-away experiments and with predictions of a simple two group diffusion model. By applying the neutron wave technique to lattices with empty channels, the determination of direction-dependent diffusion and moderation parameters is shown to be possible without the necessity of varying the system dimensions. (auth) (UK)

31106 CALCULATIONS AND EXPERIMENTS FOR A Pu FUELED MICROLATTICE WITH Gd AS A BURNABLE POISON. Arcipiani, B.; Caldognetto, U.; Gibello, A.; Pistella, F. (CNEN, Rome). Energ. Nucl. (Milan); 17: 312-16(May 1970).

Power distributions and reactivity worths were investigated in different patterns of a UO_2-PuO_2 microlattice where a number of pins were replaced by UO_2 pins containing Gd_2O_3. A good agreement between calculations and experiments was found. The calculational methods adopted proved reliable to investigate reactivity control by means of a high cross section burnable poison. 20 references. (auth)

31107 DEVICE FOR SAMPLE IRRADIATION WITH ADJUSTABLE NEUTRON FLUENCE. Kolb, M.; Krull, W. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik; 12: 178-81(Apr 1970). (In German and English).

A facility built at the FRG-1 reactor makes it possible to irradiate samples with dimensions up to 20 cm × 4 cm diameter in a thermal neutron flux specifiable within the range from 2×10^{13} cm^{-2} s^{-1}. The irradiation facility consists of a basket which can travel in a tube over a distance of 4 m and is equipped with a beta current neutron detector. This makes it possible to measure the neutron flux density at the location of the sample both before and during irradiation, independently of the operation, layout and burnup of the reactor, and of the setting of the trimmer rods. The current generated by the beta current neutron detector forms the input of an electronic integrator circuit, the last member of which is a preset-counter triggering off a visual and/or acoustic alarm signal when the preset fluence is reached. This makes it possible to irradiate samples exactly up to the desired fluence independently of the operation regime of the reactor. (auth)

31108 IN-CORE RADIATION DETECTOR FOR MONITORING PULSED REACTOR EXCURSIONS. Todt, W. H. (Westinghouse Electric Corp., Elmira, N. Y.). Genshiryoku Kogyo; 16: No. 2, 73-6(Feb 1970). (In Japanese).

A highly special detector is necessary for the measurement of radiation in a pulse-reactor core. As the design characteristics required for it, high response and the saturation of current density due to high-intensity core radiation during the pulse. For the purpose of detecting transient thermal-neutron flux of $\leq 10^{18}$ n/cm^2 sec, a vacuum-chamber detector has been developed. With the operation in vacuum, it is devoid of high-dose rate saturation seen in a gas-filled one. The vacuum-chamber detector has exhibited superior performance in the Pulstar and TRIGA reactors, and its high endurance has also been shown in TRIGA. The central electrode of the detector is coated with ^{10}B-enriched boron, and $^{10}B(n,\alpha)^7Li$ reaction is utilized. Secondary electrons are emitted in large amounts when the reaction products from the coating enter the surface of an opposite electrode. (NSA of Japan)

31109 VERSATILE TANGENTIAL IRRADIATION FACILITY. Nichol, L.; Lopez, A.; Robertson, A.; Prestwich, W. V.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Nucl. Instrum. Methods; 81: 263-9(1970).

A new beam port arrangement which has been installed in a swimming pool reactor is described. The design permits a wide range of experimental configurations to be easily implemented. The physical details of the facility and examples of typical experiments which have been undertaken are presented. (auth)

31110 ORR EMERGENCY COOLING FAILURE. Epler, E. P. Nucl. Safety; 11: 323-7(Jul-Aug 1970).

Three identical units that supply emergency power for afterheat protection of the Oak Ridge Research Reactor failed simultaneously, and the reactor was operated without emergency power for the afterheat removal system for 5 hr before the condition was discovered. The incident was caused by seven common mode failures or errors in three identical channels—a total of 21 failures. Had any one of these not happened, the reactor would not have been started up without the availability of emergency cooling from the three inoperative units. The reactor was not endangered because a dissimilar unit of low reliability was activated. It is noteworthy that this problem occurred in a plant with an outstanding safety and availability record. 6 references. (auth)

Rocket and Space Reactors

Refer also to abstract 29946.

31111 (AD-701352) SPACE ELECTRICAL POWER SYSTEMS FOR THE MID-1970's. Final Technical Report. Silverman, Richard V. (Navy Space Systems Activity, Los Angeles, Calif.). Sep 1969. 122p. (NSSA-R-40-69-4). CFSTI.

An evaluation of candidate electrical power systems capable of providing up to 6.5 kW for an earth orbiting mission is presented. Three power systems could be ready for a mid-1970 launch, if proper funding were provided for development programs. They are: a Solar Cell/Battery System; a Reactor/Thermoelectric System; and a Reactor/Organic Rankine System. The preferred system for the proposed mission is the Reactor/Thermoelectric system, based on its inherent simplicity, lower weight, lower unit costs, and high degree of technology readiness relative to the competing systems. (auth) (USGRDR)

31112 (N-70-17470) INVESTIGATION OF GASEOUS NUCLEAR ROCKET TECHNOLOGY. Summary Technical Report, September 15, 1963-November 15, 1969. McLafferty, G. H. (United Aircraft Corp., East Hartford, Conn.). Nov 1969. Contract NASw-847. 139p. (NASA-CR-107869; H-910093-46). CFSTI.

A feasibility study was made of a gaseous nuclear rocket engine concept: the closed-cycle nuclear light bulb engine. This engine is based on the transfer of energy by thermal radiation from gaseous nuclear fuel suspended in a neon vortex through an internally cooled transparent wall to seeded hydrogen propellant. Such an engine offers the possibility of providing values of specific impulse greater than 1500 sec, values of thrust-to-weight ratio greater than 1, and containment of the gaseous nuclear fuel without loss of fuel or fission products in the exhaust from the engine. In addition, it may be possible to obtain many reuses from such an engine by replenishing the spent recirculating fuel. Removal of the spent fuel and fission products from the engine would also reduce the radiation hazards during multiple-rendezvous missions. The investigations include: the characteristics of one-component and two-component vortex flows; the characteristics of coaxial flows; the spectral and total radiant energy emitted from the fuel-containment region; the transmission characteristics of fused silica exposed to nuclear radiation. (auth) (STAR)

31113 (N-70-19230) COMPUTER STUDY OF A DEAD-BAND CONDENSING-PRESSURE CONTROL FOR SNAP-8 STARTUP. Tew, Roy C.; Gallagher, James D. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb 1970. 28p. (NASA-TM-X-1964; E-5384). CFSTI.

A digital-computer simulation of the SNAP-8 space power system was used to evaluate a method for condensing-pressure control during system startup. Hg-condensing pressure is controlled by varying the condenser-coolant (NaK) flow rate whenever the pressure goes outside a dead-band. Control parameters studied were pressure dead-band width, valve gain defined as rate of change of flow over flow, and initial coolant flow through the condenser. System characteristics studied were the amount of Hg that accumulates in the condenser and the Hg flow ramp rate. (auth) (STAR)

31114 (N-70-19269) EXPERIMENTAL INVESTIGATION OF REACTOR-LOOP TRANSIENTS DURING SNAP-8 POWER CONVERSION SYSTEM STARTUP. Jefferies, Kent S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 16 Dec 1969. 22p. (NASA-TM-X-52735). CFSTI.

From startup tests of a SNAP-8 power conversion system using a realistic reactor simulator, the following conclusions were drawn: the temperature derivatives of the simulator coolant were considerably less than the reactor's limitations during all of the startup; the peak values of reactor-simulator power and outlet temperature approached the reactor's limitations during a few startups; increasing mercury-flow-ramp duration from

30 seconds to 100 seconds caused a 30 percent reduction of the maximum temperature derivative; reactivity coefficients determined from tests of the SNAP-8 reactor caused more severe over-shoots of temperature and power than the design coefficients; and the over-shoots in temperature and power could be diminished by modifying control drum logic during startup. (auth) (STAR)

31115 (N–70–19270) DESIGN AND PERFORMANCE OF AN EXPERIMENTAL START PROGRAMMER FOR A SNAP-8 SPACE POWER SYSTEM. Frye, Robert J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 16 Dec 1969. 14p. (NASA-TM-X–52734). CFSTI.

A programmer to automate the SNAP-8 Hg-loop startup started the system from an initial condition in which all system pumps were powered by an auxiliary power source at reduced frequency and in which there was no mercury in the mercury pump. The final condition at the end of startup was self-sustaining operation of Hg loop and all pumps were powered by the turbine-alternator at rated frequency. The programmer was successfully used for 26 mercury-loop startups. (auth) (STAR)

31116 (N–70–19353) INVESTIGATION OF PUMP TRANSFER FREQUENCIES FROM AUXILIARY POWER TO ALTERNATOR POWER DURING STARTUP OF THE SNAP-8 SYSTEM. Soeder, Ronald H.; Lottig, Roy A. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 13 Nov 1969. 55p. (NASA-TM-X–52712). CFSTI.

System startup tests were conducted in order to evaluate SNAP-8 startup procedures. A critical parameter in startup is the frequency of the power supplied to the four system pumps by a battery-inverter unit during the initial part of the startup. During the startup testing, inverter frequencies ranging from 220 to 290 cycles per second were investigated. The lower frequency limit was found to be 270 cycles per second. This limit was based on the criterion that the mercury-pump pressure output must be sufficient to permit simple open-loop control of the mercury flow ramp. (auth) (STAR)

31117 (N–70–23100) STUDY OF BRAYTON CYCLE POWER GENERATION SYSTEM USING SNAP-8 NUCLEAR REACTOR AS AN ENERGY SOURCE. Guentert, Donald C.; Johnson, Roy L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr 1970. 32p. (NASA-TN-D–5751; E–5317). CFSTI.

Estimates of system characteristics were obtained for a SNAP-8 reactor-powered Brayton system. At 950 K turbine inlet and 978 K reactor outlet temperatures and a 600-kW reactor power, a net unconditioned power output between 97 and 135 kW, including a 10% design margin, can be obtained at specific radiator areas between 53 and 71 sq ft/kW electric. Unshielded system specific weight is estimated to be about 150 lb/kW electric. At 894 K turbine inlet and 922 K reactor outlet temperatures, power output is 108 kW electric at a specific radiator area of 77 sq ft/kW electric. Selection of cycle design conditions and working fluid molecular weight is discussed. (auth) (STAR)

31118 (N–70–23226) NEUTRONIC DESIGN OF A REACTOR CORE CONTAINING HEAT PIPES FOR APPLICATION TO A NUCLEAR AIRPLANE. Puthoff, Richard L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). [1969]. 21p. (NASA-TM-X–52765; E–5571). CFSTI.

A study was conducted to perform the neutronic calculation on the proposed heat pipe reactor design. The study revealed that utilizing heat pipes for a nuclear airplane reactor application appeared promising when heat pipe performance was applied to the limit of heat pipe technology. The design parameters calculated are number of heat pipes, radial heat flux, core diameter, core L/D, heat pipe vapor temperature, fuel enrichment, fuel loading, clad temperature, clad stress, and power. (auth) (STAR)

31119 REACTOR CONTROL VIA STATE VARIABLE FEEDBACK. Weaver, L. E.; Schultz, D. G. (Univ. of Arizona, Tucson). pp 180–91 of Computing Methods in Optimization Problems. Berlin; Springer-Verlag (1969).

From 2nd International Congress on Computing Methods in Optimization Problems, San Remo, Italy. See CONF-680977.

A conceptual controller for a thermionic nuclear reactor space power plant utilizing state variable feedback is discussed. The computation and implementation problems usually associated with high order optimal control problems are avoided by a simplified mathematical formulation in which constraints are added in the physical system rather than in the modeling process. This deceptively simple approach is made possible by plant input limiting before state variable feedback is used to form the closed loop system. Frequency domain methods are used throughout. 12 references. (auth)

31120 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1971. PART 1. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-FIRST CONGRESS, SECOND SESSION ON GENERAL, SPACE NUCLEAR PROGRAM, AND RADIATION PRESERVATION OF FOODS, FEBRUARY 3, 18, AND 19, 1970. Washington, D. C.: Joint Committee on Atomic Energy (1970). 489p. GPO $1.75.

The hearings on the U. S. AEC authorization bill for fiscal year 1971 review the Commission's operating funds and its requests for funds for plant and capital equipment. Part I of the hearings, together with supporting documentation, is presented. (H.D.R.)

31121 APPLICATION OF NUCLEAR SOLID-CORE ROCKETS TO INTERPLANETARY ORBITAL LAUNCH BY MULTIORBIT INJECTION. Funk, Jack; McAdoo, Stewart F. Jr. Manned Spacecraft Center, Houston, Tex.). J. Spacecraft Rockets; 7: 605–7(May 1970).

A technique for injection of spacecraft out of Earth orbit by use of a nuclear rocket with a 75,000 lb thrust is described. The multiorbit injection technique consists of a series of thrusting subarcs separated by elliptical orbits about the Earth. The performance of nuclear solid-core engines is evaluated for multiorbit injection of manned spacecraft with initial gross weights of 1.5 to 2.25 million lb. (H.D.R.)

31122 THERMIONIC REACTOR SYSTEMS. A REVIEW. Davis, J. P. (Jet Propulsion Lab., Pasadena, Calif.). Mech. Eng., 92: No. 6, 42–6(Jun 1970).

The three most popular configurations of thermionic reactor systems are described and their general characteristics are discussed. Major problem areas, such as fuel swelling and emitter contamination, and performance of components and systems are examined. (H.D.R.)

31123 ACOUSTIC INSTABILITIES IN A CONSTANT-FLUX GAS-CORE NUCLEAR ROCKET. McNeil, Harry; Becker, Martin (Rensselaer Polytechnic Inst., Troy, N. Y.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 354–7(Feb 1970).

The similarity of the core of the gaseous core nuclear rocket to the combustion chamber of a chemical rocket invites speculation that acoustic instabilities, which have been troublesome in chemical rocket systems, may also occur in the gaseous core nuclear rocket system. Such instabilities can occur in compressible fluids with pressure dependent heat generation. A simplified and idealized physical model of a gaseous core nuclear rocket is presented in which the gasdynamic field is perturbed by wave phenomena while the neutron field is assumed constant. A simple stability criterion is obtained from this model in terms of the equilibrium values of the state variables and the size of the system. The criterion is applied to a reference case with the result that instability is predicted for nuclear rockets well within the size envelope presently proposed in conceptual designs. 13 references. (H.D.R.)

Process Heat and Desalination Reactors

31124 (ORNL–4538) NUCLEAR DESALINATION PROGRAM ANNUAL PROGRESS REPORT ON ACTIVITIES SPONSORED BY THE ATOMIC ENERGY COMMISSION FOR PERIOD ENDING OCTOBER 31, 1969. Anderson, T. D.; Thompson, W. E. (comps.) (Oak Ridge National Lab., Tenn.). May 1970. Contract W-7405-eng-26. 52p. Dep. CFSTI.

Information is presented under the following headings: desalting plant system coupling studies; dual-purpose plant control studies; tradeoffs between electric power generation and transmission for large nuclear desalting plants; unclad-metal-fueled breeder reactor for desalting or power; metal-fueled pressurized-water reactor; general studies on agro-industrial complexes and of agricultural and industrial processes; applications of agro-industrial complexes; and Nuclear Desalination Information Center. (D.C.C.)

Marine and Portable Power Reactors

Refer also to abstract 29989.

31125 (N–70–19325) CHECK OF A THREE-DIMENSIONAL REACTOR SHIELDING CODE BY COMPARISON WITH ML-1 REACTOR EXPERIMENT. Wohl, Millard L.; Schamberger, Robert D. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb 1970. 7p. (NASA-TM-X–1956; E–5017). CFSTI.

The three-dimensional Monte Carlo reactor shielding code was used to compute the dose rates 500 feet from the center of the ML-1 reactor shield assembly. The ML-1 shield is a high-attenuation unit shield composed of layers of metal and borated water. The agreement between the calculated and measured dose rates was excellent, indicating the validity of using the code for analyzing reactor shield assemblies of similar materials and geometries. (auth) (STAR)

Reactor Theory

Refer also to abstract 30760.

Kinetics

Refer also to abstracts 31041–31044, 31048, and 31105.

31126 (AAEC/E–205) COLLISION PROBABILITY CALCULATIONS IN CLUSTER GEOMETRY. Doherty, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1970. 30p. Dep. CFSTI (U. S. Sales Only).

Four methods for the calculation of multigroup collision probabilities in cluster geometry are described. These are Monte Carlo, full numerical integration, numerical integration over the annuli containing rods combined with the Bonalumi approximation in the moderator annuli, and a ring smearing method again based on the Bonalumi approximation for annular geometry. Results of six group calculations for three tight, natural uranium, D_2O lattices are presented in detail. These results suggest that the ring smearing model is suitable for cluster calculations which do not require high accuracy. The largest error is in the thermal flux in the outer moderator regions. This error is a general problem inherent in the Bonalumi approximation and is not peculiar to the ring smearing model presented. (auth) (Australia)

31127 (SRARI-P–53) CALCULATION OF THE EFFECTIVE FRACTION OF DELAYED-NEUTRONS AND OF THE LIFETIME OF INSTANTANEOUS-NEUTRONS FOR FAST CRITICAL ASSEMBLIES. Zizin, M. N.; Yaroslavtseva, L. N. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1969. 27p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The methods of prompt-neutron mean lifetime and an effective delayed-neutron fraction calculation are given. Calculations for a series of critical assemblies in P_1 and S_8 approximations are carried out. Calculation results are compared with the experimental data obtained on the fast critical assemblies. (13 references) (auth)

31128 GENERAL DESCRIPTION OF THE CALCULATIONAL MODEL OF THE MOICANO-2 PROGRAM FOR FUEL CYCLE STUDIES. Bruschi, C.; Goldaniga, G.; Piazza, G. (CISE, Milan). Energ. Nucl. (Milan); 17: 285-301(May 1970).

The MOICANO-2 program solves the problem of calculating continuous axial refueling at equilibrium, in (r,z) geometry, with two-group diffusion approximation. Continuous refueling means that the fuel is assumed to flow continuously along each channel such as a fluid in steady state motion. The strong interaction between local reactivity and coolant density requires the consistency between thermal-hydraulic conditions and power distribution, relevant to the cycle considered. The thermal-hydraulic conditions are determined by working out a detailed thermal-hydraulic calculation. As a consequence, the calculation of fuel cycles results in the overall study of the reactor design. The solution of the problem is an iterative one. Finally, the program calculates the reactivity held by the coolant and that held by xenon and rhodium, and the thermal-hydraulic-neutronic configuration which the reactor has at the beginning of its life, i.e., when irradiation in the core is zero. The program is written in FORTRAN-V for a UNIVAC-1108. 9 references. (auth)

31129 FLUCTUATIONS FROM THE STEADY-STATE IN REACTOR. II. ON THE FEEDBACK EFFECTS OF TEMPERATURE. Taniguti, Akira (Tokai Univ., Tokyo); Sako, Okitsugu; Matsumura, Hiroshi. Tokai Daigaku Kiyo Kogakubu; 1969: No. 1, 19-34(Mar 1970). (In Japanese).

Previously the neutron-fluctuations in a reactor were obtained by applying Lax's general formulation as to the fluctuations of Markoffian variables from the steady-state, and it was shown that the divergent character of the neutron-fluctuations at critical state was naturally derived as long as the kinetics equation was linear. Further, the possible existence of non-divergent fluctuations at critical state was suggested. The fluctuations of neutrons, precursors, temperature in a reactor, and their power-spectra are considered, with the feedback effect of temperature included, so as to compare the results with those where the effect is not included. It is shown that, first, the fluctuations of the above-mentioned variables are convergent as the result of the feedback by temperature; second, the behavior of the fluctuations as well as the power-spectra are in good agreement with those of Saito obtained by the application of the Langevin's technique. (NSA of Japan)

31130 COMMENTARY ON THE THEORETICAL CHAMBER MODEL FOR FISSION-GAS HOLDUP BEDS. Underhill, Dwight W. (Harvard School of Public Health, Boston). Nucl. Safety; 11: 321-2(Jul-Aug 1970).

Dynamics

Refer also to abstract 31045.

Experimental Applications

Refer also to abstract 31093.

31131 (INR–1152) DETERMINATION OF STATIC MACRO-PARAMETERS FOR WWR-SM LATTICES WITH INCREASED WATER-TO-FUEL RATIO. Adamski, L.; Jozefowicz, E. T.; Jozefowicz, K.; Kowalska, K. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 50p. Dep. CFSTI (U. S. Sales Only).

Critical water-moderated and reflected cores consisting of WWR-SM fuel elements and water channels were studied. Two kinds of lattices were considered, differing by the pattern of water channels and by the water-to-fuel ratio in the core. Macroscopic lattice parameters and neutron distributions were measured and calculated. Both calculational and experimental methods are described and the calculated and measured quantities are presented together with the discussion of possible sources of errors. (18 references) (auth)

31132 (KFK–1148) STATISTICAL METHOD FOR DETERMINATION OF SUBCRITICALITY OF FAST REACTORS. Glauner, H. W.; Heusener, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Jan 1970. 10p. (In German). Dep. CFSTI (U. S. Sales Only).

For the determination of the subcriticality of a fast reactor, a method is investigated to measure and evaluate an artifically produced flux-asymmetry in the core. A neutron source is inserted in an asymmetric core position and the resultant neutron flux will be measured at two locations. As the flux-ratio of the two measurements is dependent on the subcriticality, it can be used to determine subcriticality. The advantage of the method is its simplicity, as there are no additional installations besides the normal flux detectors necessary. (auth)

31133 (LA–4337) LAPH: A MULTIGROUP PHOTON PRODUCTION MATRIX AND SOURCE VECTOR CODE FOR ENDF/B. Dudziak, Donald J.; Marshall, Alan H.; Seamon, Robert E. (Los Alamos Scientific Lab., N. Mex.). Aug 1969. Contract W-7405-eng-36. 116p. (ENDF–132). Dep. CFSTI.

The LAPH code retrieves photon production cross sections or photon production multiplicities and corresponding neutron interaction cross sections from ENDF/B (Evaluated Nuclear Data File/B). It then applies suitable weighting functions over G specified photon groups and N specified neutron broad groups to construct a G x N photon production matrix. Pointwise cross sections are first integrated over each photon energy group with constant or direct energy weighting, and then over each neutron fine group with constant weighting. Within each neutron broad group, arbitrary fine-group weighting functions are read from input. Resonance fine-group interaction cross sections and weighting functions are also read as input; at the Los Alamos Scientific Laboratory (LASL), these cross sections and weights are produced directly by a modification of the MC^2 code. Macroscopic photon production and photon energy production matrices are then computed. As an option, spatially dependent photon source vectors for transport calculations can be generated by using input scalar neutron flux vectors. Multiple zones can be accommodated with separate weighting functions for each zone. Different materials and reaction types for which photon production matrices are desired can be specified for each zone. Input is in DTF-IV format, and output photon source vectors are also in this format. A sample problem is included along with an indexed listing of the code. The code is written in FORTRAN IV for a CDC-6600 computer with a $65k_{10}$ memory. 7 references. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 29238, 29416, 29426, 29429, 29465, 29471, 29541, 29920–29924, 29935; 29938, 29970, 29983, 29999, 30002–

30016, 30018, 30020–30024, 30032, 30036, 30048, and 30050–30052.

31134 "PLASTER OF BORON", A NEUTRON SHIELDING MATERIAL. Ertl, H. H.; Bodemann, M.; Puetz, W.; von Erichsen, L. (Univ., Bonn). Atompraxis; 16: 117-19(Mar-Apr 1970). (In German).

A plaster-like material shielding thermal neutrons is described. Consisting of powdered boric acid (H_3BO_3) and gypsum ($CaSO_4$) it combines the neutron absorbing effect of boron with the consistency of plaster. Some chemical and physical properties of this material are presented. Its calculated absorption effect is confirmed by experimental data achieved with a neutron generator. (6 references) (auth)

GENERAL

31135 (AEC-tr-6931/9) NUKLEONIKA. Translation of Nukleonika; 13: 953-1034(1968). 80p. (TT-68-50011/9). Dep. CFSTI.

31136 (AEC-tr-6931/10) NUKLEONIKA. Translation of Nukleonika; 13: 1035-1100(1968). 62p. (TT-68-50011/10). Dep. CFSTI.

31137 (BNL-14661) LEAD IN THE BIOSPHERE: A CASE STUDY IN UNNECESSARY INDUSTRIAL POLLUTION. Craig, Paul P. (Brookhaven National Lab., Upton, N. Y.). [nd]. 6p. Dep. CFSTI.

31138 (CALT-822-7) TEMPERATURE AND FIELD DEPENDENCE OF MAGNETIZATION OF AMORPHOUS (Fe,Mn)-P-C ALLOYS. AEC Research and Development Report No. 6. Sinha, Ashok K. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Jul 1970. Contract AT(04-3)-822. 18p. Dep. CFSTI.

31139 (COO-235-68) PROGRESS REPORT, MAY 1969-MAY 1970. (Indiana Univ., Bloomington). Contract AT(11-1)-235. 10p. Dep. CFSTI.

31140 (COO-910-19) BOVINE LYMPHOCYTIC LEUKEMIA: STUDIES OF ETIOLOGY, PATHOGENESIS AND MODE OF TRANSMISSION. Progress Report No. 10, May 1, 1969-April 30, 1970. Sorensen, D. K. (Minnesota Univ., St. Paul. Coll. of Veterinary Medicine). 30 Apr 1970. Contract AT(11-1)-910. 38p. Dep. CFSTI.

31141 (COO-910-20) EPIDEMIOLOGICAL STUDIES ON THE NATURAL TRANSMISSION OF BOVINE LEUKEMIA. Larson, V. L.; Sorensen, D. K.; Anderson, R. K.; Perman, V. (Minnesota Univ., St. Paul. Coll. of Veterinary Medicine). [1969]. Contract AT(11-1)-910. 13p. Dep. CFSTI.

31142 (COO-910-21) ISOLATION OF C TYPE VIRUS PARTICLES FROM LEUKEMIC AND LYMPHOCYTOTIC CATTLE. Dutta, S. K.; Larson, V. L.; Sorensen, D. K.; Perman, V.; Weber, A. F.; Hammer, R. F.; Shope, R. E. Jr. (Minnesota Univ., St. Paul. Coll. of Veterinary Medicine). [1969]. Contract AT(11-1)-910. 12p. Dep. CFSTI.

31143 (COO-1029-29) EFFUSION. VI. VELOCITY DISTRIBUTIONS OF GASEOUS CsCl FROM NEAR-IDEAL AND RIGHT-CIRCULAR CYLINDRICAL ORIFICES. Wang, K. C.; Wahlbeck, P. G. (Illinois Inst. of Tech., Chicago. Dept. of Chemistry). [1969]. Contract AT(11-1)-1029. 40p. Dep. CFSTI.

31144 (COO-1198-722) DELAYED FLUORESCENCE AS A PROBE OF RADIATIONLESS TRANSITIONS IN ANTHRACENE AND ALGAE. Stacy, William Turlay (Illinois Univ., Urbana). Jun 1970. Contract AT(11-1)-1198. 119p. Dep. CFSTI.

31145 (COO-1222-34) IMPROVED EXPONENTIAL DILUTION FLASK FOR GAS CHROMATOGRAPHY. Lorenz, L. J.; Culp, R. A.; Dixon, R. T. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). [1970]. Contract AT(11-1)-1222. 11p. Dep. CFSTI.

31146 (COO-1222-35) IMPROVED GAS CHROMATOGRAPHIC SEPARATIONS OF ENANTIOMERIC SECONDARY AMINE DERIVATIVES. Corbin, J. A.; Rogers, L. B. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). [1970]. Contract AT(11-1)-1222. 31p. Dep. CFSTI.

31147 (COO-1222-36) HIGH-PRECISION GAS CHROMATOGRAPHY. Culp, R. A.; Lochmueller, C. H.; Moreland, A. K.; Swingle, R. S.; Rogers, L. B. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). [1970]. Contract AT(11-1)-1222. 17p. Dep. CFSTI.

31148 (COO-1222-37) EFFECTS OF SLOW MASS TRANSFER WHEN USING MICROPOROUS ADSORBENTS IN GAS-SOLID CHROMATOGRAPHY. Moreland, A. K.; Rogers, L. B. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). [1970]. Contract AT(11-1)-1222. 44p. Dep. CFSTI.

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